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MERRIMACK RIVER BASIN  
EPSOM, NEW HAMPSHIRE

NORTHWOOD LAKE DAM  
NH 00285

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM



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ELECTE  
JUL 09 1985  
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DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION, CORPS OF ENGINEERS  
WALTHAM, MASSACHUSETTS, 02154

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| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br>The dam is a concrete gravity structure about 165 ft. long and 13 ft. high. The overall condition of the dam is good. The dam has a spillway adequate to pass only 10 percent of the estimated PMF. More detailed hydrological and hydraulic studies are therefore needed to refine the Spillway Design Flood for this low dam and determine appropriate spillway capacity or the ability of the dam to withstand overtopping. |                       |   |

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424 TRAPELO ROAD  
WALTHAM, MASSACHUSETTS 02154

REPLY TO  
ATTENTION OF:  
NEDED

OCT 12 1979

Honorable Hugh J. Gallen  
Governor of the State of New Hampshire  
State House  
Concord, New Hampshire 03301

Dear Governor Gallen:

Inclosed is a copy of the Northwood Lake Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER  
Colonel, Corps of Engineers  
Division Engineer

Incl  
As stated

NORTHWOOD LAKE DAM  
NH 00285

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MERRIMACK RIVER BASIN  
EPSOM, NEW HAMPSHIRE

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

PHASE I REPORT  
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Northwood Lake Dam, I.D. NH 00285  
State Located: New Hampshire  
County Located: Merrimack  
Town Located: Epsom  
Stream: Little Suncook River  
Date of Inspection: June 5, 1978

BRIEF ASSESSMENT

Northwood Lake Dam is a concrete gravity structure approximately 165-foot long and 13-foot high. The spillway is a concrete broad crested overflow weir approximately 110-foot long and 12-foot wide.

The overall physical condition of the dam is good. The dam has a spillway adequate to pass only 10 percent of the estimated Probable Maximum Flood (PMF), the recommended test flood, before overtopping the concrete non-overflow section of the dam. More detailed hydrologic and hydraulic studies are therefore needed to refine the Spillway Design Flood for this low dam and determine appropriate spillway capacity or the ability of the dam to withstand overtopping.

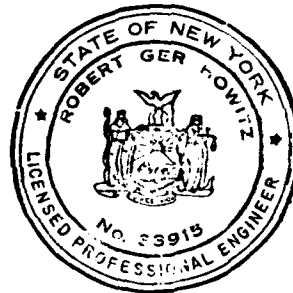
It is recommended that the owner, within 12 months after receipt of this Phase I Report, acquire basic engineering data in the form of an accurate and complete set of as-built plans, sections and details of the dam and its upstream and downstream reaches that will allow the proper assessment of hydraulic capacity.



Recommended maintenance actions to be completed within 12 months relate to the selective clearing of trees in the area downstream of the spillway and along the banks of the river reach between the dam axis and the roadway bridge downstream of the dam.

The low level outlet hoist is improperly attached to its base and should be reattached. Other recommended repairs to the hoist mechanism are described in Section 7.3.

*Robert Gershowitz, PE*  
Robert Gershowitz, P.E.



This Phase I Inspection Report on Northwood Lake Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

*Charles G. Tiersch*

CHARLES G. TIERSCH, Chairman  
Chief, Foundation and Materials Branch  
Engineering Division

*Fred J. Ravens, Jr.*

FRED J. RAVENS, Jr., Member  
Chief, Design Branch  
Engineering Division

*Saul Cooper*

SAUL COOPER, Member  
Chief, Water Control Branch  
Engineering Division

APPROVAL RECOMMENDED:

*Joe B. Fryar*

JOE B. FRYAR  
Chief, Engineering Division

## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe condition be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

|   | Page   |
|---|--------|
| TRANSMITTAL LETTER                              | i      |
| BRIEF ASSESSMENT                                | ii-iii |
| REVIEW BOARD SIGNATURE SHEET                    | iv     |
| PREFACE   | v      |
| TABLE OF CONTENTS                               | vi-vii |
| OVERVIEW PHOTO                                  | viii   |
| LOCATION MAP                                    | ix     |
| REPORT  |        |
| <u>SECTION 1 - PROJECT INFORMATION</u>          |        |
| 1.1 General                                     | 1      |
| 1.2 Description of Project                      | 2      |
| 1.3 Pertinent Data                              | 6      |
| <u>SECTION 2 - ENGINEERING DATA</u>             |        |
| 2.1 Design                                      | 9      |
| 2.2 Construction                                | 9      |
| 2.3 Operation                                   | 9      |
| 2.4 Evaluation                                  | 10     |
| <u>SECTION 3 - VISUAL INSPECTION</u>            |        |
| 3.1 Findings                                    | 11     |
| 3.2 Evaluation                                  | 14     |
| <u>SECTION 4 - OPERATION PROCEDURES</u>         |        |
| 4.1 Procedures                                  | 15     |
| 4.2 Maintenance of Dam                          | 15     |
| 4.3 Maintenance of Operating Facilities         | 15     |
| 4.4 Description of any Warning System in Effect | 16     |
| 4.5 Evaluation                                  | 16     |
| <u>SECTION 5 - HYDRAULIC/HYDROLOGIC</u>         |        |
| 5.1 Evaluation of Features                      | 17     |
| <u>SECTION 6 - STRUCTURAL STABILITY</u>         |        |
| 6.1 Evaluation of Structural Stability          | 21     |

11/11

TABLE OF CONTENTS

(Continued)

|   | Page |
|---|------|
| <b><u>SECTION 7</u> - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES</b> |      |
| 7.1 Dam Assessment  |      |
| a. Condition  | 23   |
| b. Adequacy of Information  | 23   |
| c. Urgency  | 23   |
| d. Need for Additional Investigations                                       | 23   |
| 7.2 Recommendations   |      |
| a. Data Acquisition   | 24   |
| b. Investigation  | 24   |
| 7.3 Remedial Measures   |      |
| a. Alternatives   | 25   |
| b. O&M Maintenance and Procedures   | 25   |

APPENDICES

|            |   |      |
|------------|---|------|
| APPENDIX A | CHECKLISTS - VISUAL OBSERVATIONS                              |      |
|            | - ENGINEERING, CONSTRUCTION<br>MAINTENANCE DATA               | 1-14 |
|            | - SUMMARY OF ENGINEERING DATA                                 | 15   |
| APPENDIX B | PHOTOGRAPHS   |      |
| APPENDIX C | PLATES  |      |
|            | PLANS & DETAILS OF DAM - Drawings 1, 2 & 3                    |      |
|            | GEOLOGICAL MAP                      Drawing 4                 |      |
| APPENDIX D | HYDROLOGIC COMPUTATIONS                                       | 1-25 |
| APPENDIX E | INFORMATION AS CONTAINED IN THE<br>NATIONAL INVENTORY OF DAMS |      |



### NORTHWOOD LAKE DAM

General view of the dam from downstream looking toward the right abutment. The stop plank section and the low level outlet are in the foreground, the spillway section is in the background.



VICINITY MAP

Quadrangle: Grossville, N.H.  
Scale: 1 : 62,500

PHASE I INSPECTION REPORT  
NORTHWOOD LAKE DAM NH 00285

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. HARRIS-ECI ASSOCIATES has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed was issued to HARRIS-ECI ASSOCIATES under a letter of June 7, 1978 from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW 33-78-C-0305 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-federal dams.

(3) To update, verify and complete the National Inventory of Dams.



## 1.2 Project Description

### a. Location

Northwood Lake Dam is located on the Little Suncook River in the Town of Epsom, Merrimack County, New Hampshire, approximately 2 miles upstream of the hamlet of Epsom. The Little Suncook River is a tributary to the Suncook River and is part of the Merrimack River drainage basin.

### b. Description of Dam and Appurtenances

Northwood Lake Dam is a concrete gravity structure originally built across the Little Suncook River in 1926. The impounded lake is apparently of natural origin and has been raised by the dam. No record plans of the dam exist, and all following dimensions are approximate and subject to verification and possible revision. According to existing records, the dam is approximately 165-foot long, 13-foot high and impounds 2,600 acre-feet derived from a tributary drainage area of 20.7 square miles. The spillway section is constructed of concrete and has a flat crest approximately 12-foot wide. The spillway length is listed variously as 109 and 111 feet but appeared to be shorter on the visual inspection, possibly as a result of a reconstruction completed in 1973.

The area downstream of the spillway section is partly blocked by tree growth. Large stone blocks have been placed downstream of the spillway in order to dissipate the energy of the overflowing water. The low level outlet is located adjacent to the left side of the spillway section and consists of a passage approximately 2.4-foot wide and approximately 4-foot high, controlled by a sluice gate mounted on the upstream face of the dam. The low level sluice gate hoist is housed in a small building on top of a short non-overflow section adjacent to the spillway. A new 12-foot wide stop plank section has been added to the dam in 1973, located to the left of the low level outlet. The entire structure has apparently been founded on ledge rock. Cutoff at the abutments has been

accomplished by means of cutoff core walls running into higher ground on both sides. The left abutment core wall is approximately 32-foot long. The right abutment core wall is about 20-foot long, and was added in 1973. An 8-inch thick concrete facing has been added to the upstream face of the spillover section at an unknown time after the original construction was completed.

Northwood Lake is fairly heavily developed along its rim and some artificial sandy beaches have been located along the shore line. No signs of slope instability could be detected at the visual observation.

The downstream channel of the Little Suncook River is well defined with a rocky bottom. The hamlet of Epsom is the first significant settlement, some 2 miles downstream of the dam axis, with a population estimated at about two hundred persons.

c. Size Classification

According to the "Recommended Guidelines of the Safety Inspection" by U.S. Department of the Army, Office of the Chief of Engineers, the dam is classified in the dam size category as being "Intermediate" since its storage is more than 1,000 acre-feet, but less than 50,000 acre-feet. The dam is also classified as "Small" because its height is less than 40 feet. The overall size classification is determined by the larger of these two classifications, and accordingly Northwood Lake Dam is classified as "Intermediate" in size.

d. Hazard Classification

The dam has been classified as having a High Hazard Potential in the Inventory of Dams compiled by U.S. Army Corps of Engineers on the basis that excessive damage could occur to downstream property in the event of failure of the dam and its appurtenances, together with the possibility of losing more than a few lives. This inspection concurs with the assessment on the basis that the dam impounds considerable volume

of water and that in a case of hypothetical dam failure, the nearest populated settlement at Epsom would have only approximately 10 minutes to implement flood evacuation procedures.

e. Ownership

Northwood Lake Dam is owned by the New Hampshire Water Resources Board (NJ-WRB) headquartered at Concord, New Hampshire.

f. Operator

The Northwood Lake Dam is operated by the N.H. Water Resources Board, headquartered at Concord, New Hampshire - Telephone: (603) 271-3405.

g. Purpose of Dam

The purpose of the dam is recreation and flood control.

h. Design and Construction History

The dam was built in 1926 for Suncook Mills for conservation purposes. The lake at that time was known as Suncook Pond. In 1957, the ownership passed to the N.H. Water Resources Board. No data has been uncovered as to the design and construction history of the dam from available information sources.

i. Normal Operating Procedures

The dam is used to regulate the level of Northwood Lake, by means of uncontrolled flow over the broad crested spillway section, and selective use of the low level outlet and stop plank section. Control of the lake's water surface has been facilitated by the construction of the stop plank section in 1973 which allows a faster regulation and control of the lake surface. The lake level is maintained within one foot of the spillway crest level in the summer months and is drawn down several feet in the winter to accommodate significant snowmelt inflows in the

spring. The lake is considered "flashy" in that the level of the lake rises fairly rapidly in response to ordinary rainfalls over its drainage area. Depending on the season, the lake is visited weekly or semi-weekly by a NH-WRB dam operator to adjust the outflows at the dam in order to achieve targeted lake levels.

1.3 Pertinent Data

a. Drainage Area 20.7 square miles

b. Discharge at Dam Site

Maximum known flood at dam site: 725 cfs (estimated)

Warm water outlet at pool elevations: NA

Diversion tunnel low pool outlet at pool elevation: NA

Diversion tunnel outlet at pool elevation: NA

Gated spillway capacity at pool elevation: NA

Gated spillway capacity at maximum pool elevation: NA

Ungated spillway capacity at maximum pool elevation: 350 cfs (Elev. 519.3)

Total spillway capacity at maximum pool elevation: 350 cfs (Elev. 519.3)

c. Elevation (Feet above MSL)

Top of dam: 519.3

Maximum pool design surcharge: 519.3

Full flood control pool: NA

Recreation pool: 518.16

Spillway crest: 518.16

Upstream portal invert diversion tunnel: NA

Downstream at centerline diversion tunnel: NA

Streambed at centerline of dam: 505 ± (estimated)

Maximum tailwater: Unknown

d. Reservoir

Length of maximum pool: 3.4 miles (estimated)  
Length of recreation pool: 3.0 miles (estimated)  
Length of flood control pool: NA

e. Storage (acre-feet)

Recreation pool: 2,400 (Elev. 518.16)  
Flood control pool: NA  
Design surcharge: 3,000 {  
Top of dam: 3,000 { Elev. 519.3

f. Reservoir Surface (acres)

Top of dam: Not available  
Maximum pool: Not available  
Flood control pool: Not available  
Recreation pool: 589  
Spillway crest: 589

g. Dam

Type: Concrete gravity  
Length: 169 feet  
Height: 12 feet  
Top width: 12 feet  
Side Slopes - Upstream: Vertical  
- Downstream: Vertical  
Zoning: Not applicable  
Impervious core: Not applicable  
Cutoff: The main part is built on rock with  
concrete cutoff walls at both abutments  
Grout curtain: None

h. Diversion and Regulating Tunnel

Type: Not applicable  
Length: NA  
Closure: NA  
Access: NA  
Regulating facilities: NA

i. Spillway

Type: Broad crested overflow weir  
Length of weir: 109.5 (from available records)  
but seems shorter from visual observations  
Crest elevation: 518.16  
Gates: None  
U.S. Channel: Northwood Lake  
D/S Channel: Natural channel of Little Suncook  
River

j. Regulating Outlets

Low level outlet: Listed as 3 ft. x 5 ft., estimated at  
28 in. x 48 in. during inspection  
Controls: Sluice gate at upstream face of dam  
Emergency gates: None  
Outlet: Downstream channel of Suncook River

k. Stop Plank Section

Passages: 3  
Width: 40 in., 38 in., 40 in. net width between  
retaining beams  
Supports: 8 x 8 steel beams, hinged at bottom  
Stop planks: Individual, 7 1/2 in. high  
Invert of passage: Elev. 511.4

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SECTION 2  
ENGINEERING DATA

2.1 Design

No design data has been recovered for the original dam built in 1926. There are no record or design drawings, hydrologic or stability computations of any kind in the files of the N.H. Water Resources Board (NH-WRB). The dam was modified in 1973 by the NH-WRB by the addition of a 12-foot stop plank section. The plans for this modification consist of marked up drawings of another NH-WRB dam at Silver Lake adapted to Northwood Lake. These modified drawings are shown as Drawings 2 and 3, appended. The marked up drawings bear little or no similarity to the actual structure. A sketch of the actual structure is shown on Drawing 1, made during the visual inspection. No computations relating to hydraulics, hydrology, foundation condition or structural analysis of the 1973 dam modifications were recovered from the NH-WRB files.

2.2 Construction

No data or information has been recovered from any source relating to the construction of the dam except that it was built in 1926.

2.3 Operation

No data on the operation of the dam has been recovered except as given by the NH-WRB dam operator at the time of the visual inspection.



## 2.4 Evaluation

### a. Availability

The available information is virtually non-existent. Although plans for the 1973 stop plank modification are available, they relate only to the details of the modification and not to the general dam setting. There is no set of as-built plans for the dam, and several key dimensions relating to the spillway and low level outlet are not confirmable. No documented data exists on the foundation level or materials overlying the bedrock surface.

### b. Adequacy

The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

### c. Validity

The validity of the plans and pertinent data recovered is very questionable. The spillway length is variously given as are the dimensions of the low level outlet. Freeboard dimensions are not consistent. All previously assembled pertinent data cannot be confirmed by the visual inspection. Until as-built drawings are produced, all dimensions are considered questionable, except for the details specifically dimensioned on the stop plank section modification.

SECTION 3  
VISUAL INSPECTION

3.1 Findings

a. General

The general condition of Northwood Lake Dam is good. The dam has been modified and has received maintenance since the time it has been acquired by the N.H. Water Resources Board (NH-WRB).

b. Dam

The dam is a concrete gravity structure founded on ledge rock. The abutment contacts are in the form of cutoff walls extending from the spill-over and stop plank sections into higher ground. The right cutoff wall is of recent construction, dating to 1973. No visible seepage could be discerned, however the spillway was overflowing on the day of inspection and obscured a large part of the downstream face. The original concrete in the spillway section was in fair to good condition, showing moderate signs of freeze-thaw weathering and water caused erosion. No surface cracking or major structural cracking could be detected. No monolith joints were visible but the spillway horizontal lift joints were visible on the downstream face of the spillway and exhibited minor local erosion and deterioration. The horizontal and vertical alignment of the spillway crest was good to excellent. The top of the broad crested weir was estimated to be level within a 1 inch tolerance over its entire surface. An 8-inch thick facing apparently has been added to the upstream face of spillway section at some time after the original construction. The spillway is ungated and currently no flash boards are used, although apparently in the past they have been. The freeboard between the spillway crest and the top of the dam is extremely limited, amounting to only 13-15 inches. The listed spillway length is 109.5 feet; however, the spillway looked shorter on visual inspection and the dimension should be verified.

Adjacent to, and to the left of the spillway, a short non-overflow section houses the low level outlet gate and its gate house (see Drawing 1). The low level outlet passage has been variously listed as being 3 x 3, or 3 x 5 ft. in size, and is controlled by timber sluice gate on the upstream face of the dam. The size of the low level outlet is estimated at 28 x 48 inches for this inspection report and must be verified by an accurate field survey. The invert elevation of the passage is estimated at 511.4 MSL.

The gate is manually operated by a combination of worm gearing and spur gearing. The gate stem is a 4 in. by 8 in. timber equipped with a cast iron rack spiked to the stem. The stem timber appeared to be in very good condition; however, the rack showed heavy corrosion, and the top two teeth had broken off. The operating mechanism is not securely anchored to the concrete structure of the dam. The existing arrangement employs concrete and timber blocks which hold the operating mechanism approximately one foot above the floor of the gate house. This block arrangement does not have the strength to withstand the horizontal forces developed by the worm gear, and at present the blocks deflect slightly when force is applied to the handwheels.

For this reason, it is recommended that a new hoist pad be poured and properly anchored to the dam structure.

The operating mechanism employs a back up roller which holds the gate stem and rack against the pinion gear and prevents the timber stem from deflecting. Originally this roller was held in place by two cast iron bearing caps bolted to the mechanism frame. Apparently, these iron bearing caps have either broken or become excessively worn, because at the time of this inspection the back up roller shaft was held in place by wooden blocks bolted to the frame. If either of these wooden bearing caps were to fail, the gate would be inoperable until a replacement is fabricated.

In general, because of the many minor deficiencies in the operating mechanism, this gate is considered to lack operational reliability.

Adjacent and to the left of the low level outlet (see Drawing 1) a stop plank section has been installed in a modification made by the NH-WRB in 1973. The stop plank section is 12-foot wide overall with a fixed concrete sill at an elevation estimated to be at 511.4. There are three individual stop plank passes supported by vertical wide flange steel beams and side wall grooves. The individual stop planks are 2 1/2 x 7 1/2 inches in dimension and fit in between the flanges of the steel beams for support. The clear space between flanges of the steel beams is approximately 40-inch wide. Vertical steel beams are required to support the three sets of stop planks. In addition to the recesses in the side walls, the two central steel beams, which have stop logs on both sides, are not rigidly fixed to the dam structure. At the top of each of these two beams, there is a removable pin (1 in. dia. bar stock) securing the beam to the dam structure. In case of emergency, one or both of these pins can be removed, detaching the beam completely and removing with it all stop planks which are in place at the time.

If both center support beams were released, the resulting flow passage would be approximately 11.2-foot wide and almost the full height of the dam. The steel support beams, the retaining pins, and timber stop logs are all in very good condition.

c. Appurtenances

There are no appurtenant structures associated with this dam.

d. Reservoir

The Northwood Lake covers approximately 590 acres at normal pool levels, and is approximately three miles long. The reservoir rim slopes vary from moderately sloping to flat in places. The rim is heavily developed with shore front cottages, and some artificial beach areas have been

created. The general rim slope is heavily wooded and is locally cleared for the summer cottages. There are no signs of slope instability along the lake rim. There is some evidence of sedimentation in the part of the lake immediately behind the dam where it is naturally shallow. It is not known to what extent the channel to the low level outlet and stop plank section is silted in.

e. Downstream Channel

The immediate downstream channel of the Little Suncook River is well defined having a width of approximately 15 feet and rocky or riprapped side slopes of 1 on 4 horizontal. Immediately downstream of the dam, the transition zone area between the 110-foot wide spillway and the 15-foot wide river channel is overgrown with trees, some of which form an island. The stream reach between the dam axis and the nearest downstream road crossing also has trees growing close to the normal channel of river. All of these trees are considered a potential hazard at high spillway or outlet discharges, in that they could be uprooted and plug to the downstream bridge opening, thus creating undesirable high tailwater levels at the dam.

Large stone boulders and riprap have been placed downstream of the spillway and low level outlet to dissipate energy.

3.2 Evaluation

The dam inspection showed that the physical condition of Northwood Lake Dam is generally good, but that improvements could be made as described in Section 7.3.

SECTION 4  
OPERATIONAL PROCEDURES

4.1 Procedures

The reservoir is considered to be "flashy", in that significant fluctuations in lake levels can be expected at times of moderate rainfall. Depending on the season, the dam is visited on a weekly or semi-weekly basis by an operator of the N.H. Water Resources Board (NH-WRB) for regulation of the lake level to meet targeted lake levels. In the summer time, an attempt is made to maintain the lake level within one foot of the crest elevation by uncontrolled flow over the spillway and stop plank section, or by opening the low level outlet gate or by removing as many stop planks as deemed necessary. In the winter, the NH-WRB practice is to lower the lake level by several feet to prevent ice damage to docking facilities and to provide storage for the heavy spring time inflows due to snowmelt. Spring time low level outlet releases are keyed to the amount of the prevailing snow cover and its water content. Releases are adjusted to achieve the normal full lake elevation by early June.

4.2 Maintenance of the Dam

Maintenance of the dam has been carried out on an as-needed basis based on operations of an experienced state organization. Since the time the dam was acquired by the NH-WRB, the facility appears to have been generally rehabilitated and upgraded.

4.3 Maintenance of Operating Facilities.

The operating facilities are maintained on an as-needed basis in connection with the weekly visits by the dam operator. The low level

outlet hoist mechanism is protected from the elements and casual vandalism within a locked gate house. The stop planks are locked in their grooves against unauthorized removal.

#### 4.4 Description of any Warning System in Effect

As far as can be determined, no warning system is currently in effect to alert downstream residents of impending high stream stages, caused by operating procedures at the dam.

#### 4.5 Evaluation

The operational procedures at the dam are simple, fitting in with the simple facilities involved. In line with greater public interest in dam safety, the owner should institute a bi-annual dam inspection utilizing a simplified version of the visual check list used in this inspection report. The reports should be kept on permanent file. Maintenance schedules should be drawn up and all visits to the dam logged in a permanent record, whether for maintenance or dam operation.

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SECTION 5  
HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The evaluation of the hydraulic and hydrologic features of the Northwood Lake Dam was based on criteria set forth in the Corps' Guidelines for Phase I inspections, and additional guidance provided by the New England Division, Corps of Engineers. The Probable Maximum Flood (PMF) was estimated from guide curves from probable maximum flood for New England region, based on past Corps' studies. The PMF peak versus drainage area curves are presented in the section of hydrologic computations.

The PMF curve applicable for flat and coastal areas was adopted for the estimation of PMF peak of the reservoir. The PMF versus drainage relationship can be expressed mathematically as follows:

$$Q = 1,020.84 - 304.91 \log_{10} A$$

$$Q_p = Q \times A$$

where:

$Q$  = Unit peak discharge in cfs square miles

$Q_p$  = Peak PMF discharge, in cfs, for the reservoir

$A$  = Watershed area, in square miles, upstream of the dam axis.

The computed peak discharge of PMF and one half of the PMF for a drainage area of 20.7 square miles using the above equation are 12,826 cfs and 6,413 cfs, respectively. A triangular shaped flood hydrograph was assumed for the inflow design hydrograph.



Both the PMF and one half of PMF inflow hydrographs were routed through the reservoir by the modified Puls Method, utilizing computer program HEC-1. The peak outflow discharges for the PMF and one half of PMF are 10,870 cfs and 5,041 cfs, respectively. Both the PMF and one half of the PMF result in overtopping of the dam.

The reservoir stage-capacity curve was constructed using comparisons of both dam inventory data and planimetered areas, measured from 15-minute quadrangle topography maps. Reservoir storage capacity included surcharge levels exceeding the top of dam assumed that dam remains intact during routing. In the routing computations, the discharge through outlet facilities was excluded due to its insignificant magnitude, as compared to the spillway discharge and the PMF. The spillway rating curve and the reservoir capacity curve are presented in the section of hydrologic computations.

Since the spillway of the dam is incapable of passing the PMF or one half PMF without overtopping the dam, an assessment of downstream hazards due to a flood wave that would result in case of a hypothetical dam failure was also estimated. The magnitude of the flood wave was estimated using generally accepted "rule of thumb" computational procedures established by the New England Division, Corps of Engineers, in combination with sound hydrologic engineering judgement. Flood routing of the dam break hydrograph for downstream areas are given in the section on hydrologic computations. The result of this computation shows that in the event of a hypothetical dam failure at the time the lake level is at the top of dam, a lake discharge of about 9,250 cfs would be released. Flood stages in the downstream channel reaches are given in the following table.

TABLE 1

| <u>Distance Downstream of Dam Axis<br/>(Miles)</u> | <u>Est. Flood Stages<br/>(Feet)</u> |
|--|-------------------------------------|
| 0.05   | 9.2                                 |
| 1.0  | 12.0                                |
| 2.0 (Epsom)  | 14.0                                |
| 3.0 (Gossville)                                    | 8.5                                 |

The flood stages would affect the structural stability of buildings in the downstream reach whose foundations are below the hypothetical inundation level, and could cause large scale property damage and possible loss of lives.

Since the data used in the determination of downstream flood stages are very preliminary, it is recommended that further hydraulic studies of the downstream channel be carried out in order to accurately assess the downstream hazard to property and life due to a hypothetical dam failure.

b. Experience Data

Records of reservoir stage or spillway discharge are not available for this site. From interview with local residents, it was learned that the reservoir elevation was always below the dam crest even though the spillway is only capable of discharging about 10 percent of the PMF peak.

c. Visual Observations

The spillway structure is in good condition, hydraulically, but the low level outlet was not considered operationally reliable. Sediment deposits were observed in the reservoir adjacent to the upstream face of the right abutment. There were man made beaches along the reservoir rim. Additional sediment deposits into the reservoir from these beaches are likely, but it does not endanger the stability of the dam nor the validity of the reservoir routing.

d. Overtopping Potential

As indicated in Section 5.1.a., both the PMF and one half PMF, when routed through Northwood Lake Reservoir, result in overtopping the dam. The spillway and reservoir surcharge capacities are too small to accommodate the peak flows. The PMF and one half PMF overtopped the dam by 8.25 feet and 4.45 feet respectively (This may or may not affect the stability of the structure). The spillway is only capable of passing a flood equal to 10 percent of the PMF without overtopping the dam. Since the PMF is the Spillway Test Flood for this dam, according to the Recommended Guidelines for Inspection of Dams by the Corps, the spillway capacity of the Northwood Lake Dam is considered inadequate. In determining the spillway capacity at high discharges, the assumption was made that spillway capacity was not affected by submergence caused by high stream stages downstream, This assumption should be verified in subsequent studies.

SECTION 6  
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There are no signs of structural instability apparent on visual examination. No leakage or seepage was observed at the abutments or at the toe of the dam where not obscured by overflowing water to the spillway. The dam appeared to be in good alignment and no settlement could be detected. There were no noticeable cracks to indicated overstressed conditions. On the basis of the visual examination and the dam's 50-year service history, structural stability under present conditions is not of great concern because of the dam's low height and relatively substantial width as related to its height.

b. Design and Construction Data

Insufficient documentation has been recovered to assess the structural stability of the dam. No cross sections of the dam are available and the depth to the foundation contact is not defined. No data is available on the properties of the foundation rock on which the dam is apparently founded. There is no pertinent construction data on which an evaluation of structural stability can be founded.

c. Operating Records

No operating records for the dam have been recovered on which an opinion on structural stability can be formulated.

d. Post Construction Changes

After the New Hampshire Water Resources Board took over the ownership of the dam in 1957, the following changes have been made to the dam:

(1) The right abutment core wall was extended 20 feet into the hillside. This modification is considered beneficial to the overall stability and safety of the dam.

(2) Addition of a 12-foot wide by 6.6-foot high stop-plank section. This modification adds a considerable discharge capacity to the dam and is considered very beneficial in reducing overtopping incidents, which create the risk of potential abutment erosion and undermining.

In addition to the above modifications, the upstream spillway surface has been refaced by the addition of an 8-inch thick concrete wall. This modification is also considered beneficial to the overall stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 2 and, in accordance with the Recommended Phase I Guidelines, does not warrant seismic analyses.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

The overall physical condition of Northwood Lake Dam is good according to the visual inspection performed. The dam's overall safety is in question since the spillway capacity is only 10 percent of the PMF. The spillway discharge capacity has been estimated by current Corps of Engineers' screening criteria, and the owner should determine the spillway capacity by more sophisticated and accurate methods and procedures.

b. Adequacy of Information

The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

c. Urgency

The urgency of performing the recommendations and remedial measures are detailed below.

d. Need for Additional Investigations

There is no need for further investigations in this phase of the program. Recommended investigations to be carried out by the owner are listed below.

7.2 Recommendations

It is recommended that the owner, within 12 months after receipt of this Phase I Report, assemble the following information.

a. Data Acquisition

(1) An updated as-built set of drawings of the dam showing all pertinent details and correcting inadequacies and omissions on the presently available drawings.

(2) Additional topographic surveys should be made in the reach downstream of the dam axis including details of roadway bridge downstream of the dam.

(3) The area downstream of spillway should be topographically surveyed and all trees larger than 4 inches in diameter should be located and shown on the plans.

(4) Soundings should be made on the upstream side of the dam to determine silt and hard bottom levels.

b. Investigations

Determine and document the spillway capacity of the dam using more sophisticated and accurate methods than were used in the Phase I screening methodology employed in this report, including the routing of the inflow through the lake, and assessment of the effect of possible submergence on the spillway capacity.

Based on the results of the spillway capacity analysis, the owner should formulate plans for augmenting the spillway capacity if shown necessary.

7.3 Remedial Measures

a. Alternatives

The alternatives available for augmenting the spillway capacity of the dam are:

(1) Raising the non-overflow part of the dam to permit greater heads and discharges over and through the existing facilities.

(2) Provision of an additional auxiliary spillway on the left abutment.

(3) Seasonal regulation of the lake levels to provide additional storage capacity in anticipation of large runoff events.

(4) Combination of the above methods.

b. O&M Maintenance and Procedures

The owner should initiate the following programs:

(1) Bi-annual inspection of the dam utilizing a visual check list similar to that used in this inspection report.

(2) Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

(3) Assemble and keep on hand complete documentation of the dam design, as-built drawings, and any other data pertaining to the dam safety.

(4) Selectively clear trees in area downstream of the main spillway that could be uprooted during high spillway discharges



and cause damage to or plugging of the roadway bridge immediately downstream of dam. Selectively remove trees along the reach of Little Suncook River channel that pose a similar potential risk to the bridge.

(5) Securely fasten the low level outlet gate hoist to the floor of the gate operating house, so that it remains rigid during operation. Repair missing teeth on the gate hoist rack. Replace wooden hoist stem backing roller shaft bearing caps with cast iron ones of suitable design.

(6) Maintain a silt free channel to the low level outlet sluice gate and stop plank section of the dam.

(7) The owner should establish a formal system with local officials for warning downstream residents in case of emergency. Round the clock surveillance should be provided by the owner during periods of unusually heavy precipitation.

APPENDIX A

- CHECK LISTS: - VISUAL OBSERVATIONS
- ENGINEERING, CONSTRUCTION  
MAINTENANCE DATA
  - HYDRAULIC AND HYDROLOGIC DATA  
ENGINEERING DATA

CHECK LIST  
VISUAL INSPECTION  
PHASE 1

Name Dam NORTHWOOD LAKE DAM County Merrimack State New Hampshire Coordinators \_\_\_\_\_

Date(s) Inspection June 5, 1978 Weather Sunny Temperature 65OF

Pool Elevation at Time of Inspection 518.4 M.S.L. Tailwater at Time of Inspection 509.3 M.S.L.

Inspection Personnel:

Seymour Roth  
David Kerkes  
Yin Au-Yeung  
Recorder: Seymour M. Roth  
Lynn Brown  
William Flynn

Representing the owner, N.H. Water Resources Board:  
Mr. Lyall Milligan, Dam Operator

Note: NA means Not Applicable

CONCRETE/MASONRY DAMS

| VISUAL EXAMINATION OF                      | OBSERVATIONS   | REMARKS AND RECOMMENDATIONS |
|--|--|-----------------------------|
| SEEPAGE OR LEAKAGE                         | None visible   |                             |
| STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS | Good contact between dam masonry and apparent ledge foundation on both abutments. The left abutment cutoff wall is 20-foot long, and the right abutment cutoff wall is 32-foot long.   |                             |
| DRAINS                                     | No drains were observed.   |                             |
| WATER PASSAGES                             | Stop log slots have been added to the non-overflow section of the dam. Each of the three stop log slots is 4-foot wide and extend 6 ft.-7 in. below spillway crest level. The concrete, steel and wood components are in excellent condition. The intermediate supports are hinged to provide a 11 ft.-2 in. wide by 6.5 ft. high opening in an emergency. |                             |
| FOUNDATIONS                                | Apparently, the structure is founded on a bedrock of gneiss or schist.   |                             |

CONCRETE/MASONRY DAMS

| VISUAL EXAMINATION OF               | OBSERVATIONS   | REMARKS OR RECOMMENDATIONS |
|-------------------------------------|--|----------------------------|
| SURFACE CRACKS<br>CONCRETE SURFACES | No significant cracks can be visually observed.  |                            |
| STRUCTURAL CRACKING                 | None observed  |                            |
| VERTICAL & HORIZONTAL<br>ALIGNMENT  | The vertical alignment of the spillover section is good. Apparently, there is less than one inch difference in elevation. The horizontal alignment of the structure is good, there are no visible deviations or offsets. |                            |
| MONOLITH JOINTS                     | None observed  |                            |
| CONSTRUCTION JOINTS                 | The original concrete of the dam has been placed in 3-foot high lifts. These lift joints are partly eroded on the downstream side of the spillover section.  | No action required.        |

EMBANKMENT

| <u>VISUAL EXAMINATION OF</u>                           | <u>OBSERVATIONS</u> | <u>REMARKS OR RECOMMENDATIONS</u> |
|--|---------------------|-----------------------------------|
| SURFACE CRACKS   | Not applicable      |                                   |
| UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE      | Not applicable      |                                   |
| SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES | Not applicable      |                                   |
| VERTICAL & HORIZONTAL ALIGNMENT OF THE CREST           | Not applicable      |                                   |
| RIPRAP FAILURES  | Not applicable      |                                   |

EMBANKMENT

| VISUAL EXAMINATION OF                                 | OBSERVATIONS   | REMARKS OR RECOMMENDATIONS |
|---|----------------|----------------------------|
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | Not applicable |                            |
| ANY NOTICEABLE SEEPAGE                                | Not applicable |                            |
| STAFF GAGE AND RECORDER                               | Not applicable |                            |
| DRAINS  | Not applicable |                            |

OUTLET WORKS

| VISUAL EXAMINATION OF                                      | OBSERVATIONS  | REMARKS AND RECOMMENDATIONS   |
|--|---|---|
| CRACKING & SPALLING OF CONCRETE SURFACES IN STILLING BASIN | Not applicable  |   |
| INTAKE STRUCTURE   | None  |   |
| OUTLET STRUCTURE   | A low level outlet passage, 28-inch wide by 48-inch high, passes through the dam and is controlled by a sluice gate on the upstream face of the dam. The outlet passage concrete is in fair serviceable condition.  |   |
| OUTLET FACILITIES  | See "Concrete/Masonry Dam", "Water Passages"  |   |
| EMERGENCY GATE   | The sluice gate hoist rack is heavily corroded at the top and has two broken teeth. The hoist mechanism is poorly anchored to floor, deflecting when sluice is lifted. The lifting stem backing roller shaft is operating with wood replacement bearing caps instead of the original cast iron ones | Refurbish gate hoist system by bolting hoist to suitable concrete foundation pad.<br>Replace wooden lifting stem backing roller shaft bearing caps with cast iron ones. |



UNGATED SPILLWAY

| VISUAL EXAMINATION OF | OBSERVATIONS   | REMARKS AND RECOMMENDATIONS   |
|-----------------------|--|---|
| CONCRETE WEIR         | The concrete spillover section is approximately 80-foot long and 12-foot wide. The crest is completely flat and level. An 8-inch facing wall has been added to the upstream face of the spillover section since the original construction.   |   |
| APPROACH CHANNEL      | The approach channel is the western end of Northwood Lake which is approximately 1,000-foot wide at the outlet end.  |   |
| DISCHARGE CHANNEL     | The discharge from the spillover section rejoins the channel of the Little Suncook River. Part of the downstream area is overgrown with substantial tree growth. Heavy stone riprap channel protection has been placed downstream of the spillover section, the stop log section and the low level outlet. | Remove trees from area downstream of the spillover section. Regrade area as required to permit a smooth hydraulic transition to the downstream channel. |
| BRIDGE AND PIERS      | A concrete walkway has been placed over the stop log section to gain access to the low level outlet gate house from the left abutment.   |   |

GATED SPILLWAY

| VISUAL EXAMINATION OF       | OBSERVATIONS   | REMARKS AND RECOMMENDATIONS |
|-----------------------------|----------------|-----------------------------|
| CONCRETE SILL               | Not applicable |                             |
| APPROACH CHANNEL            | Not applicable |                             |
| DISCHARGE CHANNEL           | Not applicable |                             |
| BRIDGE AND PIERS            | Not applicable |                             |
| GATES & OPERATION EQUIPMENT | Not applicable |                             |

INSTRUMENTATION

| VISUAL EXAMINATION OF     | OBSERVATIONS  | REMARKS AND RECOMMENDATIONS |
|---------------------------|---|-----------------------------|
| MONUMENTATION/<br>SURVEYS | Not applicable  |                             |
| OBSERVATION WELLS         | Not applicable  |                             |
| WEIRS                     | Not applicable  |                             |
| PIEZOMETERS               | Not applicable  |                             |
| OTHER                     | A lake gage on the upstream face of the dam reads zero at the normal pool level Elev. 518.16 MSL. |                             |

RESERVOIR

| VISUAL EXAMINATION OF | OBSERVATIONS  | REMARKS AND RECOMMENTATIONS  |
|-----------------------|---|--|
| SLOPES                | The reservoir slope is fairly flat, 1 on 5 horizontal up to a point 5 feet above prevailing lake level, where the slope steepens. The reservoir rim is generally wooded except where locally cleared for residential development. |  |
| SEDIMENTATION         | Some sedimentation noticeable in the immediate area of the dam, but not enough to affect hydrologic or stability parameters.  | Survey lake depth behind dam to ascertain maximum drawdown potential under present conditions. |
|                       |   |  |
|                       |   |  |
|                       |   |  |

DOWNSTREAM CHANNEL

| VISUAL EXAMINATION OF                            | OBSERVATIONS  | REMARKS AND RECOMMENDATIONS   |
|--|---|---|
| CONDITION<br>(OBSTRUCTIONS,<br>DEBRIS, ETC.)     | The natural channel is unobstructed, but has a narrow foot bridge downstream of the dam axis that could be swept away and block the highway bridge across the river 200 feet downstream of the dam. | See remarks under "Ungated Spillway-Discharge Channel" Selectively remove trees likely to be uprooted under high stream flow conditions in reach between dam and highway. |
| SLOPES   | The channel is well defined with 1 on 4 horizontal riprapped banks in the 200-foot reach downstream of the dam to the highway. The stream bottom is rocky.  |   |
| APPROXIMATE NUMBER<br>OF HOMES AND<br>POPULATION | Less than 10 residences are in evidence along the banks of river in immediate downstream area. The nearest population center is Epsom, with a population estimated at several hundred people.       |   |
|  |   |   |

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION

| ITEM                         | REMARKS   |
|------------------------------|---|
| PLAN OF DAM                  | Not available   |
| REGIONAL VICINITY MAP        | Available   |
| CONSTRUCTION HISTORY         | Not available   |
| TYPICAL SECTIONS OF DAM      | Not available   |
| HYDROLOGIC/HYDRAULIC DATA    | Not available   |
| OUTLETS - PLAN               | ) Available for rebuilt stop plank section<br>)<br>)<br>) |
| - DETAILS                    |   |
| - CONSTRAINTS                |   |
| - DISCHARGE RATINGS          |   |
| RAINFALL / RESERVOIR RECORDS | Not available   |

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION  
(continued)

| ITEM                             | REMARKS                  |
|----------------------------------|--------------------------|
| DESIGN REPORTS                   | Not available            |
| GEOLOGY REPORTS                  | Not available            |
| DESIGN COMPUTATIONS              | ) )<br>) )<br>) )<br>) ) |
| HYDROLOGY & HYDRAULICS           |                          |
| DAM STABILITY                    |                          |
| SEEPAGE STUDIES                  |                          |
| MATERIALS INVESTIGATIONS         | ) )<br>) )<br>) )<br>) ) |
| BORING RECORDS                   |                          |
| LABORATORY                       |                          |
| FIELD                            |                          |
| POST-CONSTRUCTION SURVEYS OF DAM | Not available            |
| BORROW SOURCES                   | Not available            |
| SPILLWAY PLAN - SECTIONS         | ) )<br>) )               |
| - DETAILS                        |                          |

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION  
(continued)

| ITEM  | REMARKS   |
|---|---|
| OPERATING EQUIPMENT<br>PLANS AND DETAILS                        | Not available   |
| MONITORING SYSTEMS  | Not available   |
| MODIFICATIONS   | A 12-foot wide stop plank section has been added by the N.H. Water Resources Board in 1973. |
| HIGH POOL RECORDS   | Pool records are kept by the N.H. Water Resources Board.                                    |
| POST CONSTRUCTION ENGINEERING<br>STUDIES AND REPORTS            | None uncovered although stop plank section has been added for good and sufficient reasons.  |
| PRIOR ACCIDENTS OF FAILURE<br>OF DAM - DESCRIPTION<br>- REPORTS | )<br>) None known<br>)  |
| MAINTENANCE OPERATION<br>RECORDS                                | No formal records available.  |



CHECK LIST  
HYDROLOGIC AND HYDRAULIC DATA  
ENGINEERING DATA

Name of Dam: NORTHWOOD LAKE DAM

Drainage Area Characteristics: 20.7 square miles

Elevation Top Normal Pool (Storage Capacity): 518.16

Elevation Top Flood Control Pool (Storage Capacity): Not applicable

Elevation Maximum Design Pool: 519.18

Elevation Top Dam: 519.3

SPILLWAY CREST:

a. Elevation 518.16

b. Type Overflow: flat, broad crested weir

c. Width 12 feet approximately

d. Length 109.5 feet

e. Location Spillover Left side of dam

f. No. and Type of Gates None

OUTLET WORK:

a. Type Slide gate 2.4 x 4-foot high

b. Location Adjacent to left side of spillover section

c. Entrance Inverts 508.7 estimated

d. Exit Inverts 508.7 estimated

e. Emergency Draindown Facilities 12 wide stop plank section Inv. 511.4

HYDROMETEOROLOGICAL GAGES:

a. Type Staff gage

b. Location Left wingwall of dam

c. Records None available

MAXIMUM NON-DAMAGING DISCHARGE 750 cfs (estimated)

APPENDIX B

PHOTOGRAPHS

ALL PHOTOGRAPHS TAKEN ON JUNE 5, 1978

NORTHWOOD LAKE DAM

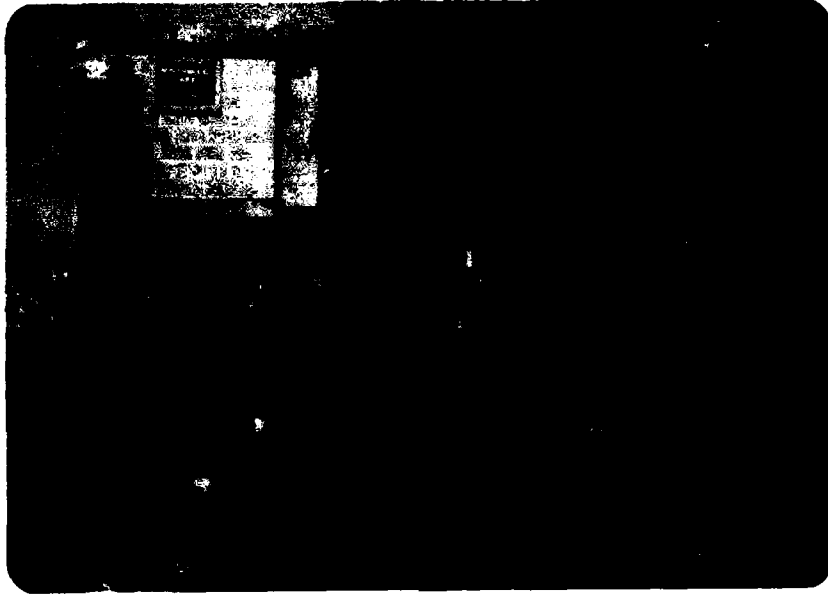


Photo 1 - View of the left abutment from downstream. The spillway is on the left of the picture, the low level outlet is in the center with the gate house over it, and the new stop plank section is on the right.

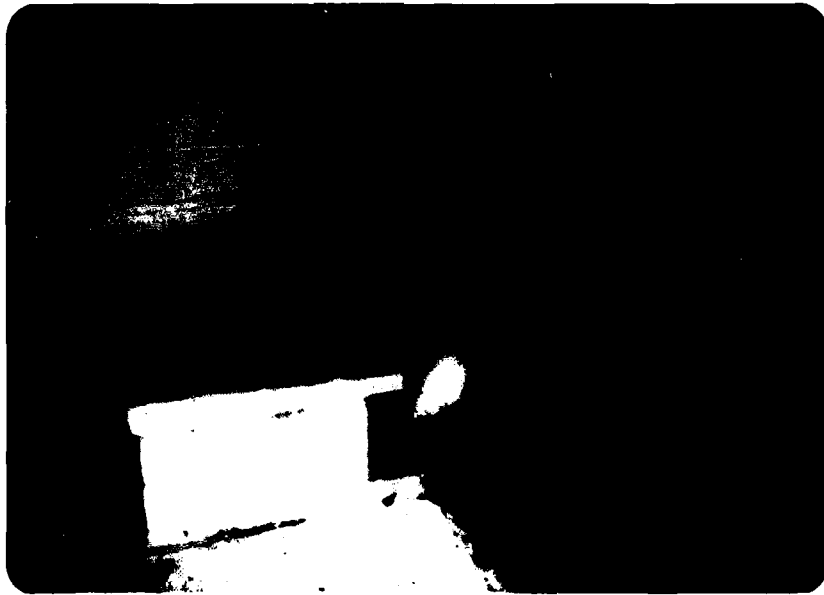


Photo 2 - Interior view of the gate house showing the gate hoist for the low level outlet. The gate hoist is inadequately anchored to the floor.

NORTHWOOD LAKE DAM



Photo 3 - View of the dam from the upstream side.

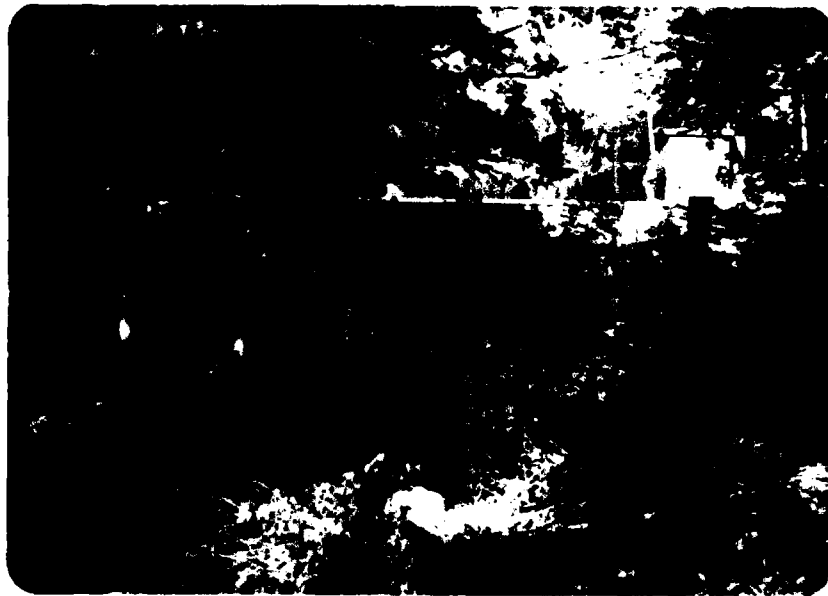


Photo 4 - View of the dam from the roadway crossing downstream of it. Note that the area downstream of the spillway on the left side of the picture is partly blocked by tree growth.

NORTHWOOD LAKE DAM



Photo 5 - View of the downstream channel of Little Suncook River taken from the dam.



Photo 6 -View of the rim of Northwood Lake taken from the dam axis.

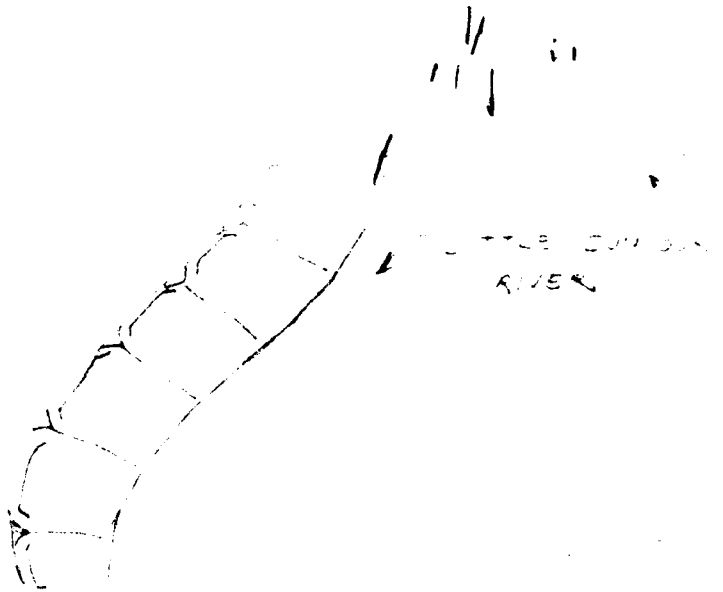
1/ 11

APPENDIX C

PLATES

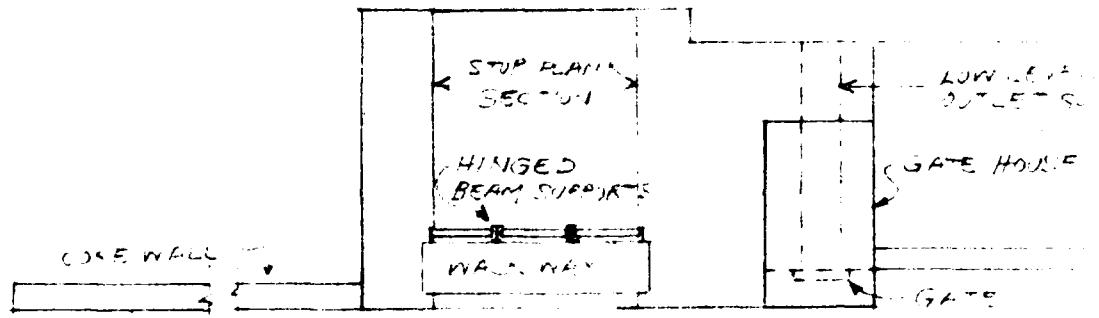
PLANS & DETAILS OF DAM  
GEOLOGIC MAP

Drawings 1, 2 & 3  
Drawing 4



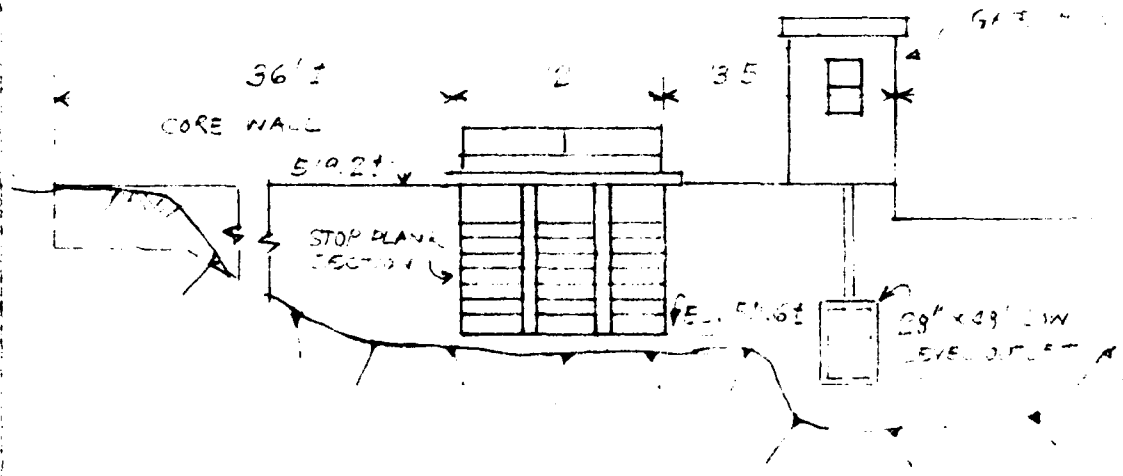
LITTLE CUMBER RIVER

ISLAND



Y  
Z  
X

LAKE SHORE



EL. 5

AREA 100

EL. 10

THE AREA EL. 10

1/11

2



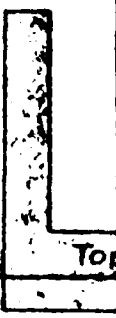
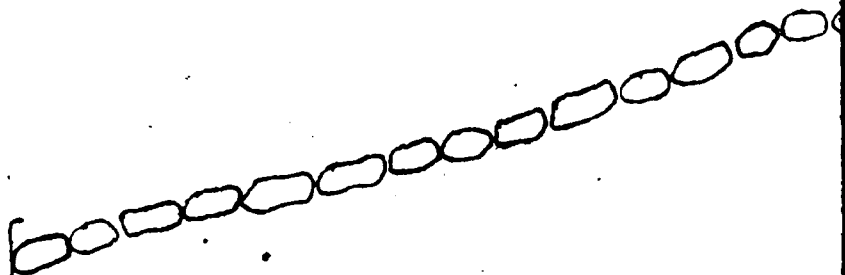
50' ± OF CURVE

EL. 53.4 TO 53.5

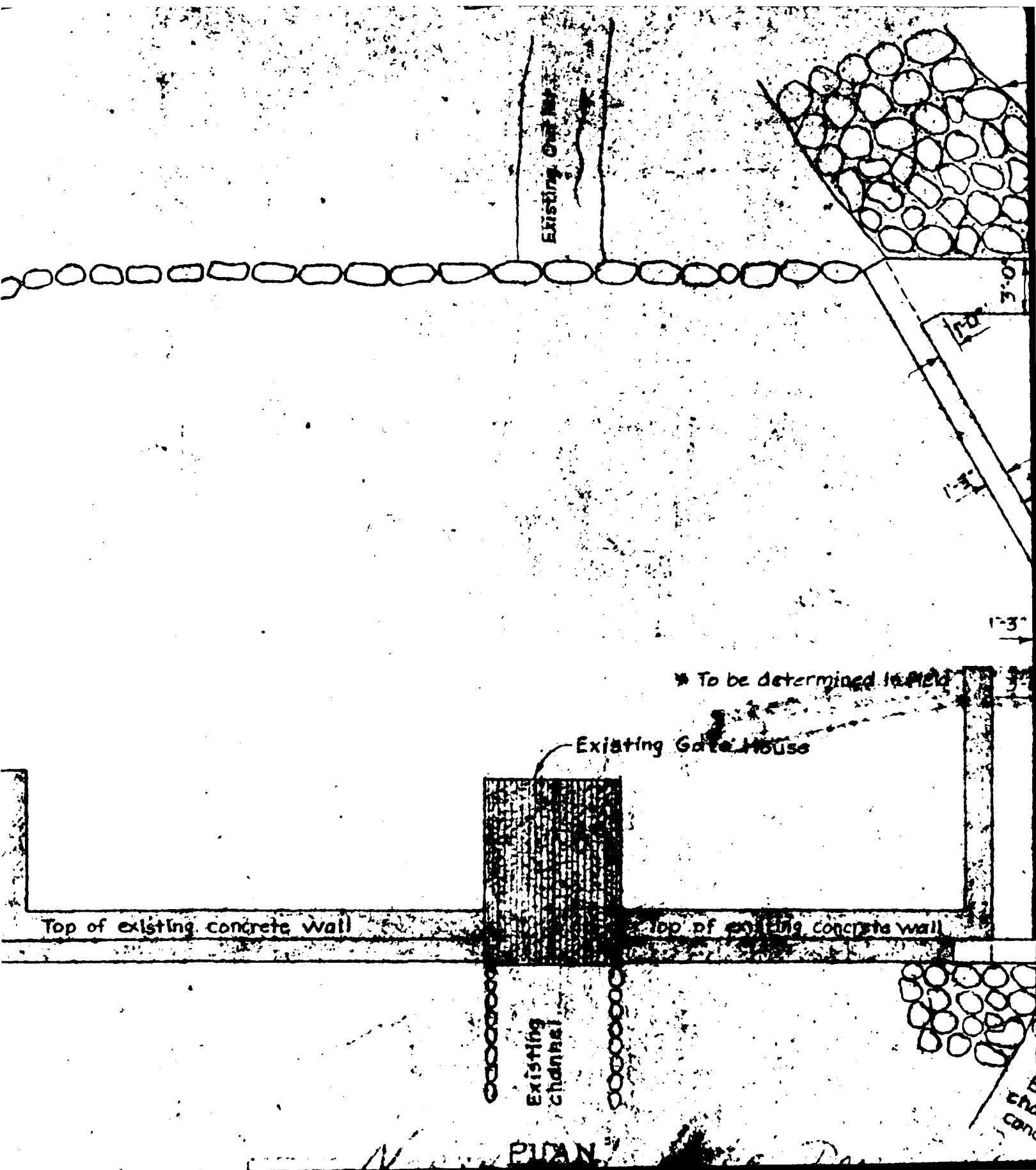
APPROXIMATE ELEVATION OF CURVE

HARRIS-ECI ASSOCIATES  
 NORTHWOOD LAKE DAM DWG.  
 FIELD INSPECTION SKETCH 1





Top



Existing Channel

To be determined in field

Existing Gate House

Top of existing concrete wall

Top of existing concrete wall

Existing channel

PLAN

Strip riprap Chink with  
stone & concrete 15 Ft from  
bottom slab. Slope to existing  
streambed elevation.

Existing  
Structure

**GENERAL NOTES**  
Concrete - All  
Reinforcing  
Place all reinf  
unless show  
All existing d  
Repair existi

determined to be  
base

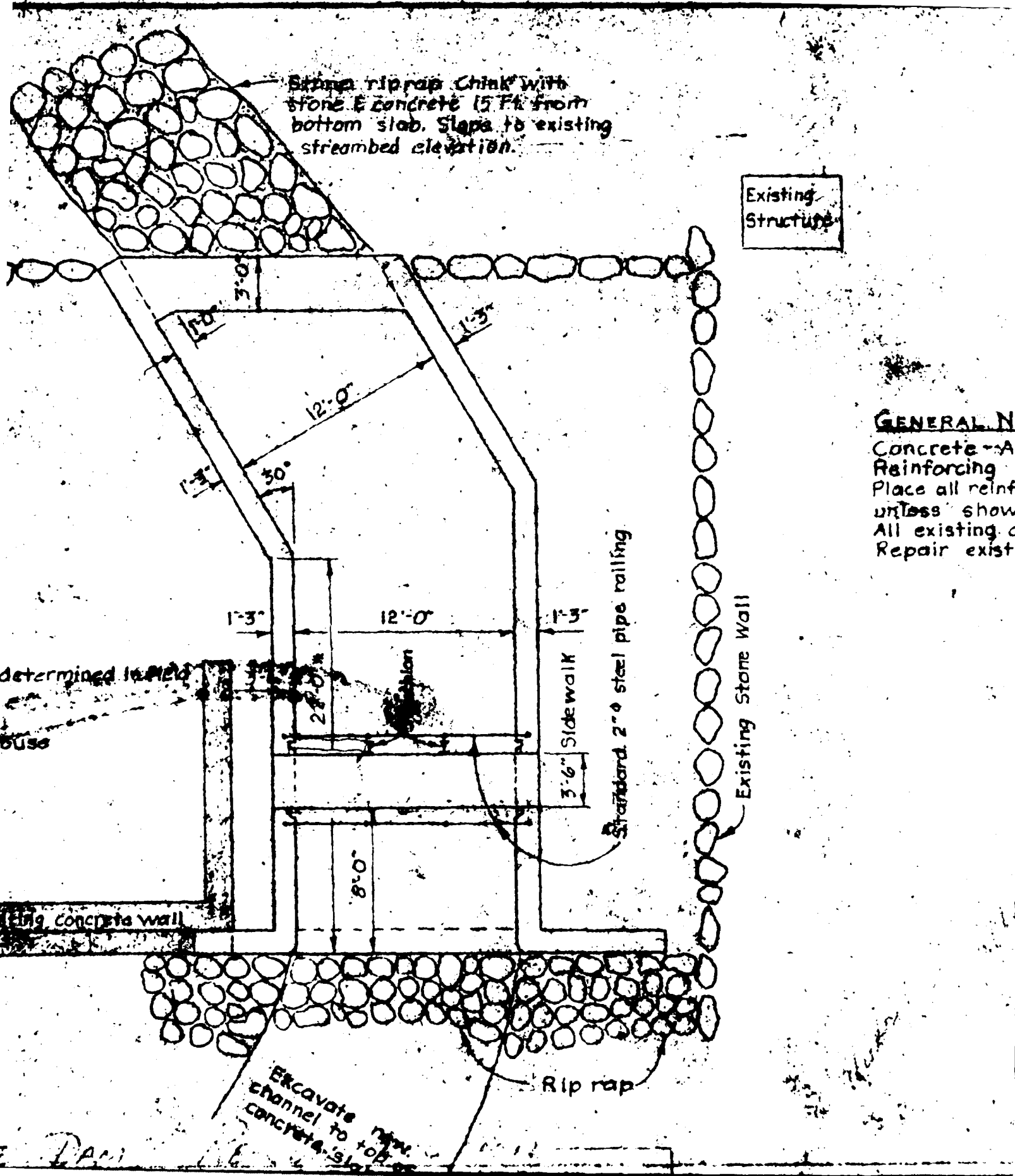
Existing concrete wall

Standard 2"  $\phi$  steel pipe railing

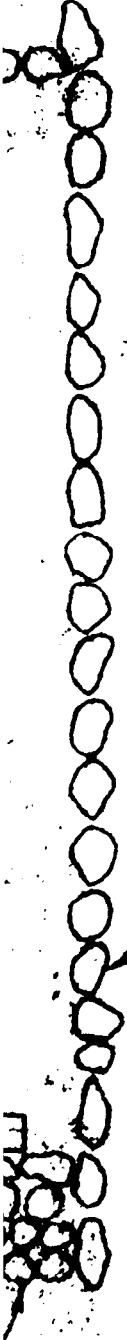
Existing Stone Wall

Rip rap

Excavate new  
channel to top of  
concrete slab



Existing  
Structure



Existing Stone Wall

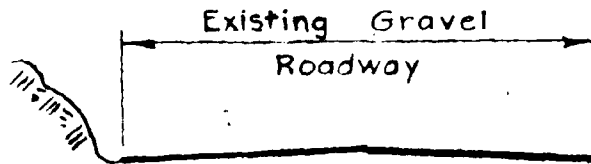
GENERAL NOTES:

Concrete - Air entrained Class A  $f_c = 3000$  psi  
Reinforcing steel - Intermediate Grade  $f_y = 20,000$  psi  
Place all reinforcing bars 3" clear of concrete surface  
unless shown otherwise.  
All existing dimensions shown shall be verified in the field.  
Repair existing gate mechanism as required.

*[Faint handwritten notes and signatures]*

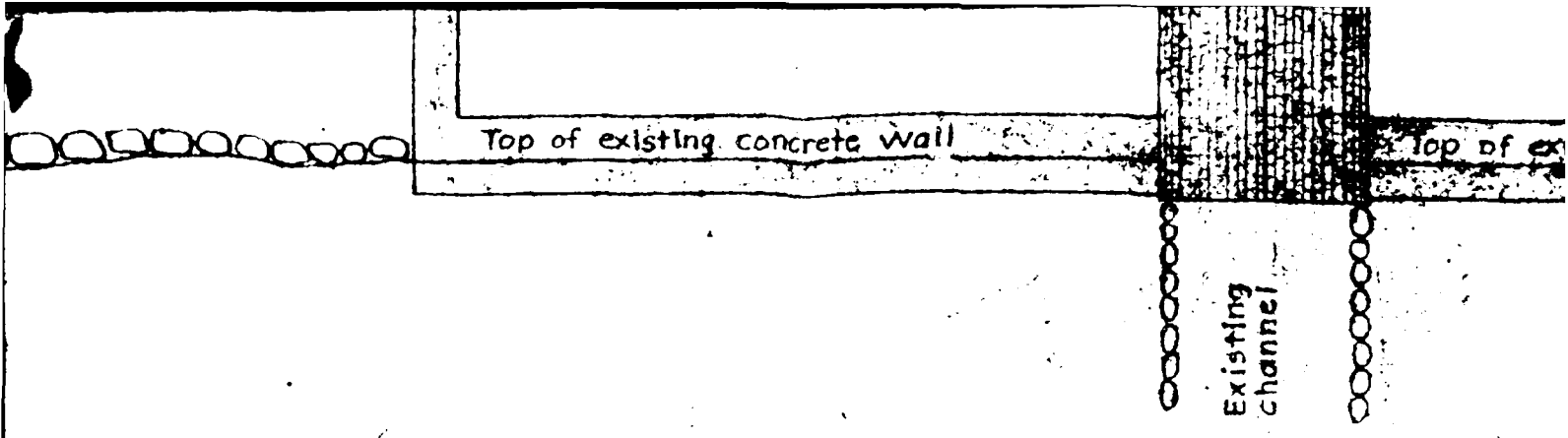
REVISIONS

DATE

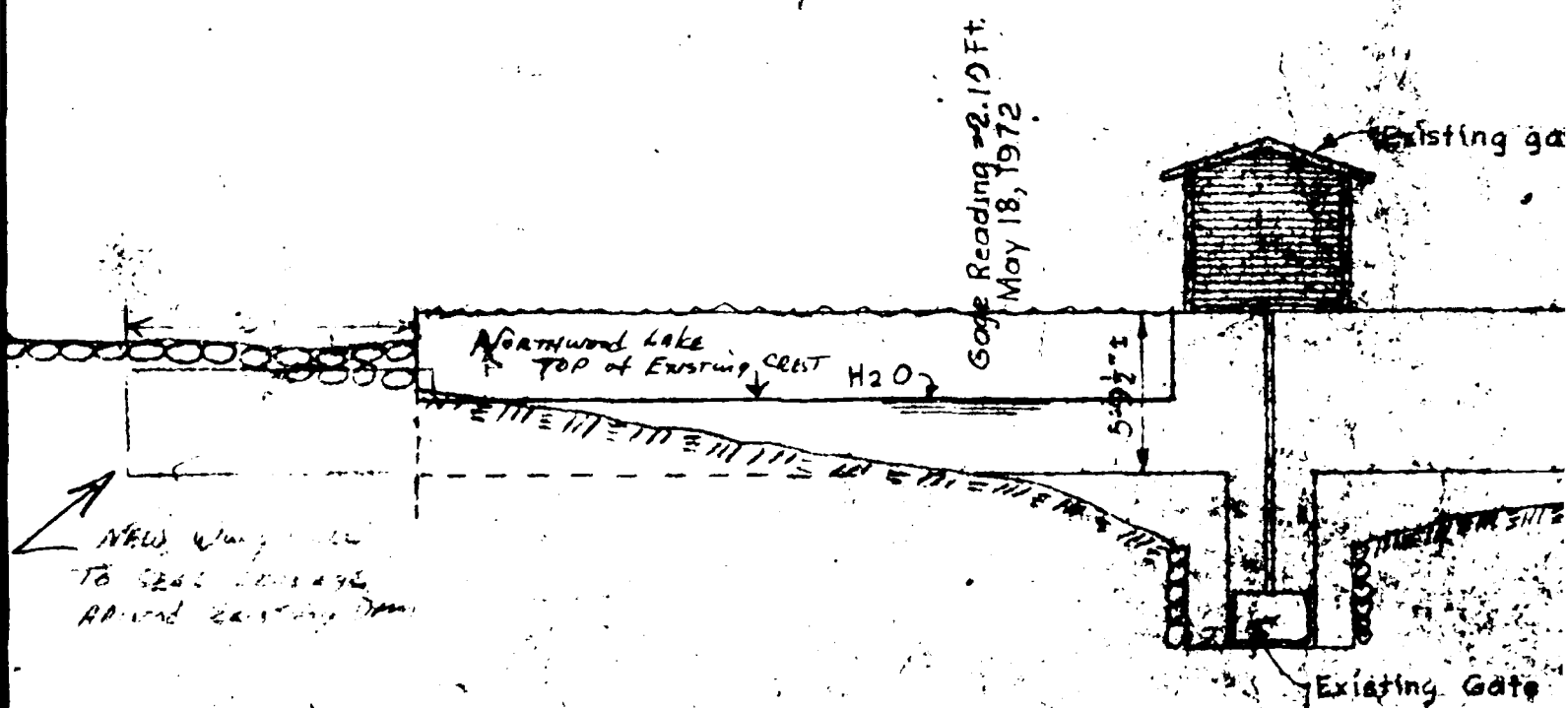


NEW WALL  
TO BE  
APPROX 20'

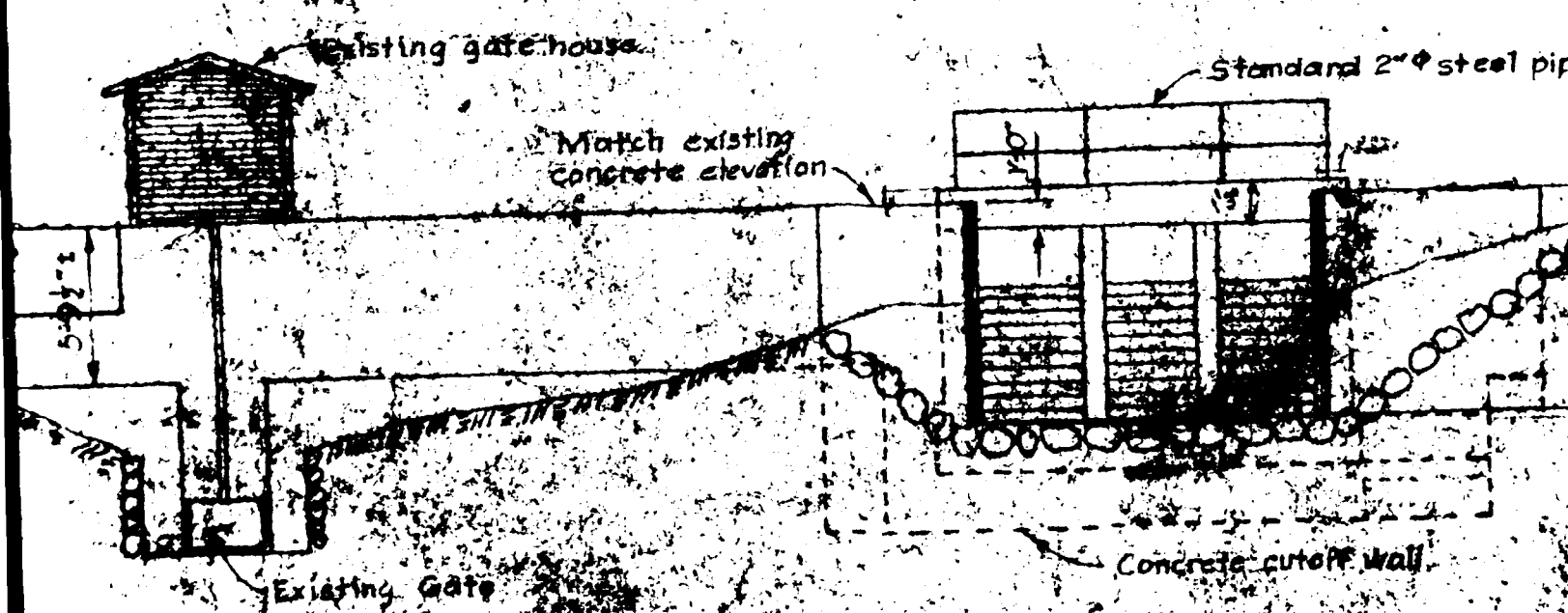
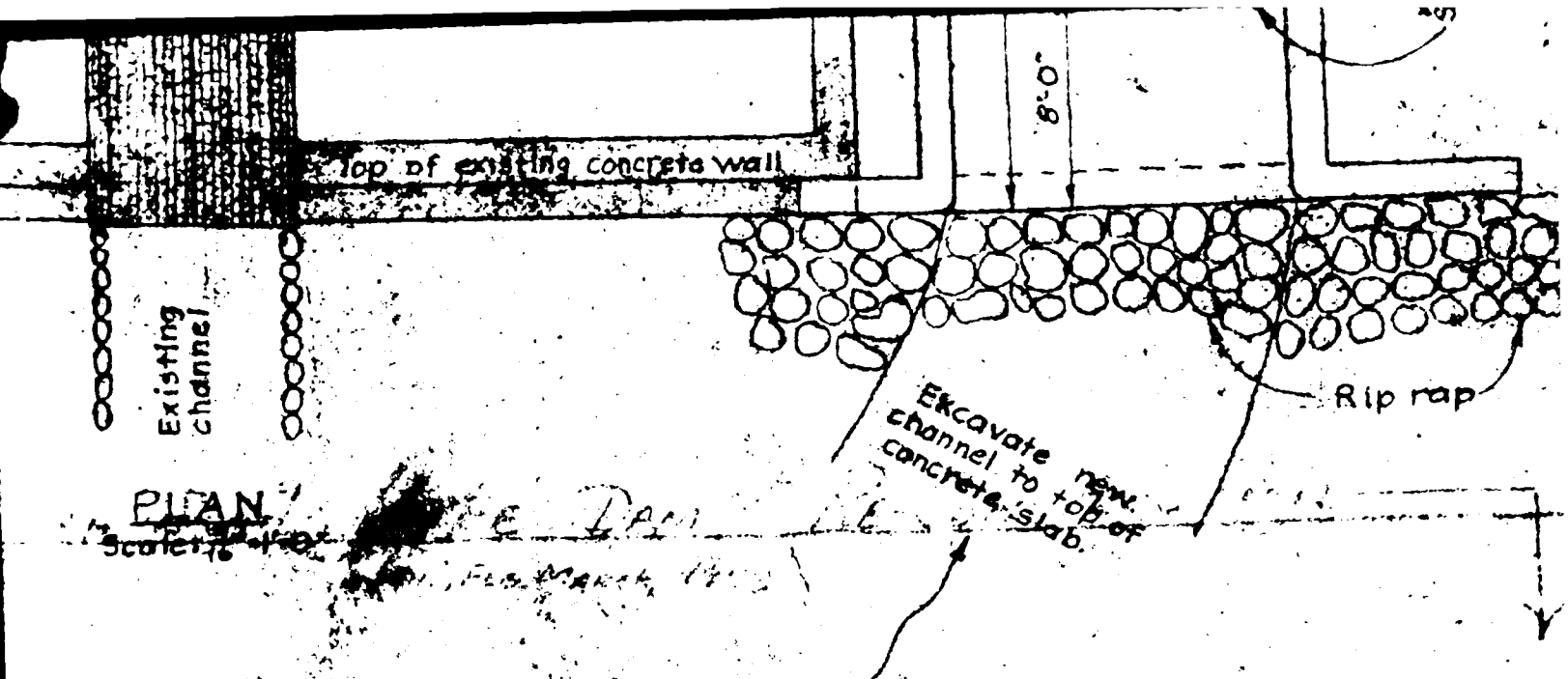
|             |                    |
|-------------|--------------------|
| Designed by | D. M. R.           |
| Drawn by    | D. M. R.           |
| Traced by   |                    |
| Checked by  | <i>[Signature]</i> |



PLAN  
Scale 1/4" = 1'-0"



ELEVATION  
Scale 1/4" = 1'-0"



**ELEVATION**

Scale: 1" = 10'

**NOTE:**  
 Window framing dimensions and steel requir  
 to be calculated after final elevations hav  
 been established in the field.

8'0"

Rip rap

Excavate new channel to top of concrete slab.

Standard 2" steel pipe fail

top Slab 101.17

Top Crest 100.00

4'8" Deep

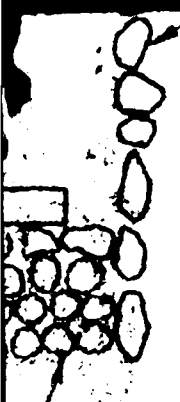
Top Slab 98.23

Concrete cutoff wall

With footing dimensions and steel requirements calculated after final elevations have established in the field.

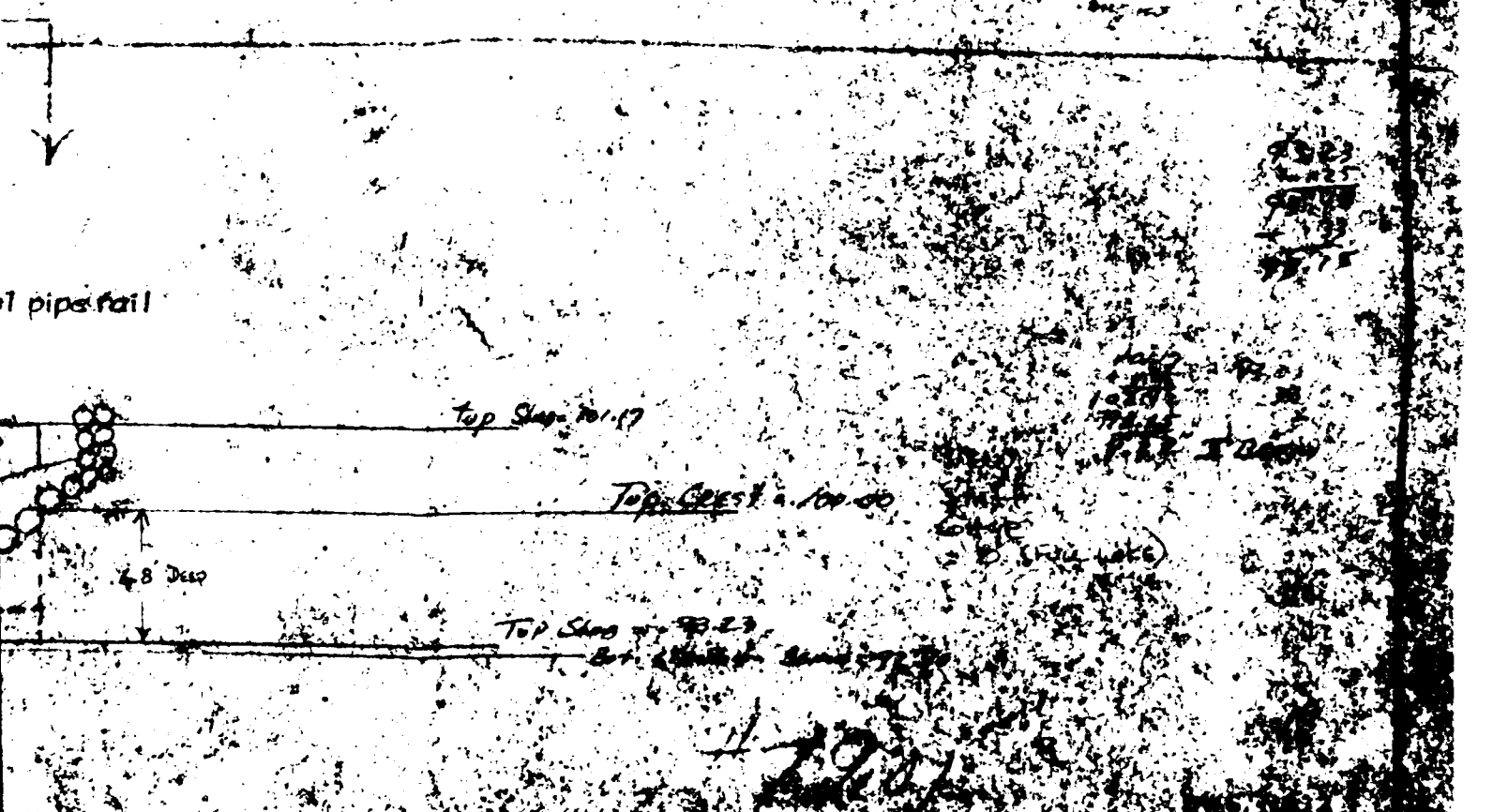
Northwood  
 ERSOY  
 [Signature]  
 [Stamp]





10/17

Handwritten notes and scribbles at the top of the page.



1 pipe fail

Top Slab 101.17

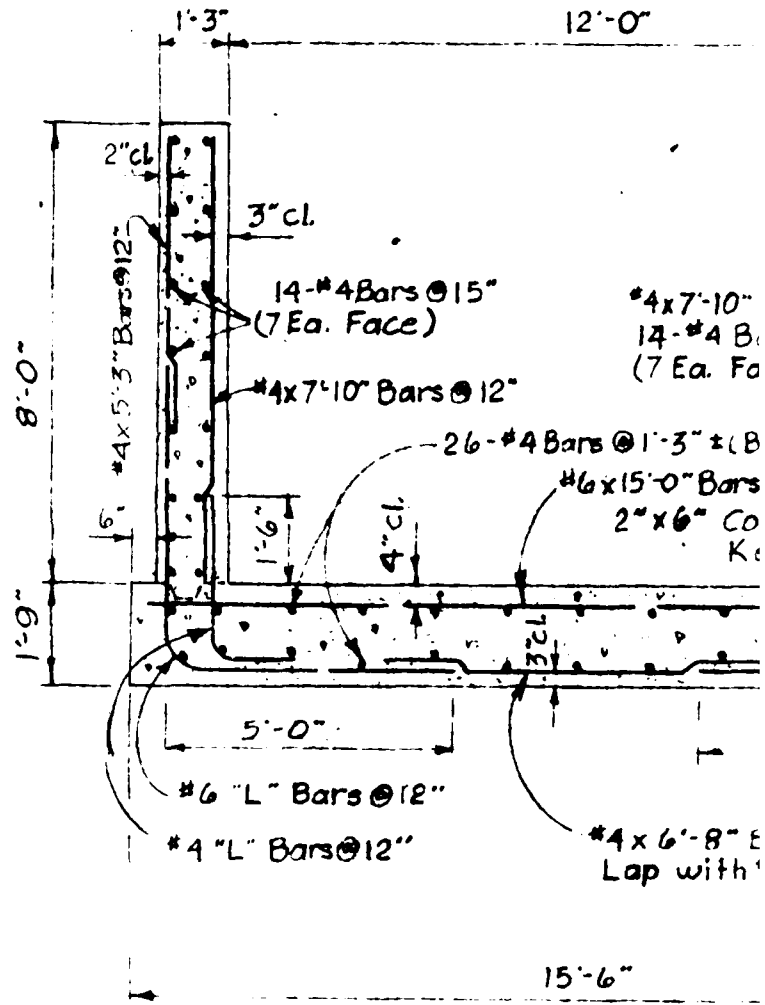
Top Chest 101.00

4.8 Deep

Top Slab 98.23

requirements have

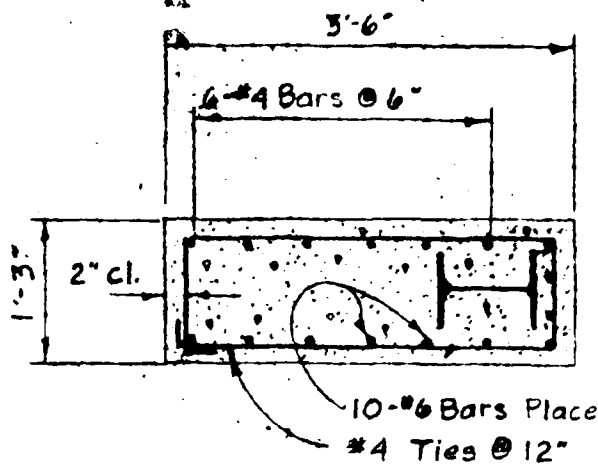
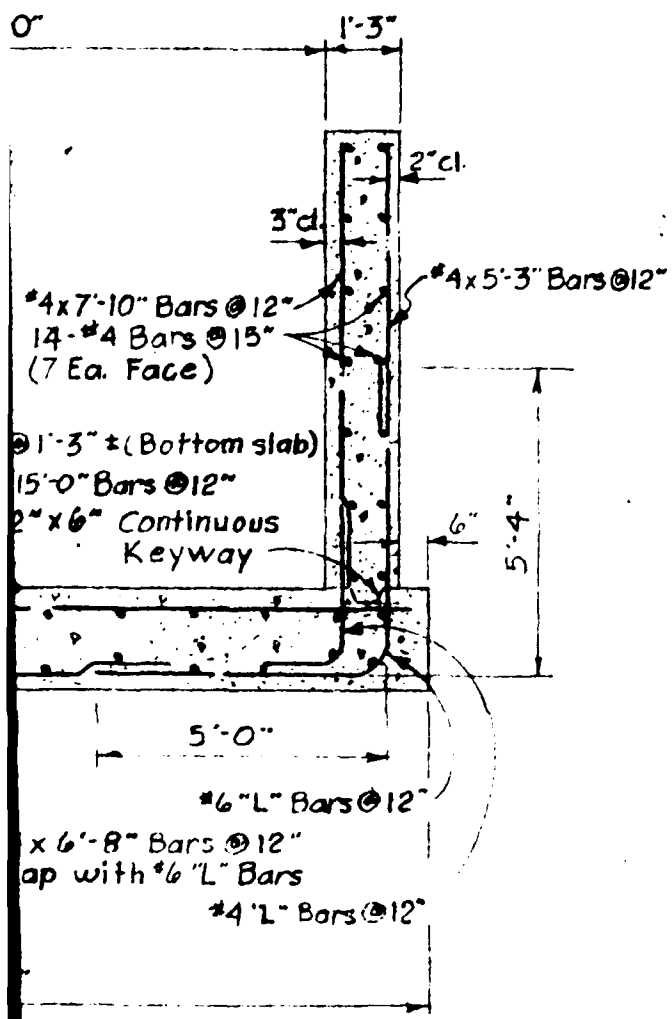
Notified  
Edson  
C. [unclear]



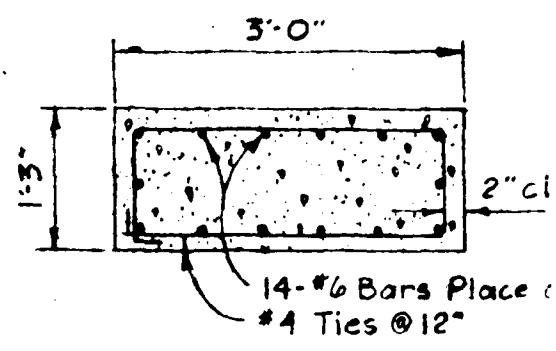
TYPICAL CHANNEL SEC  
 Scale:  $\frac{3}{8}$ " = 1'-0"

1'-3"

10'-0"



**SIDEWALK SECTION.**  
 Scale:  $\frac{3}{4}$ " = 1'-0"

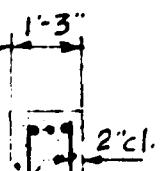
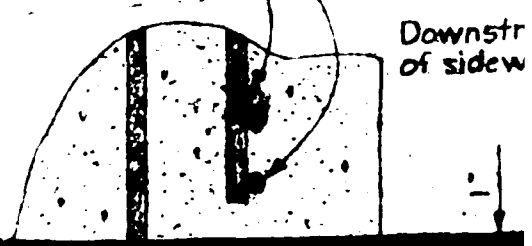


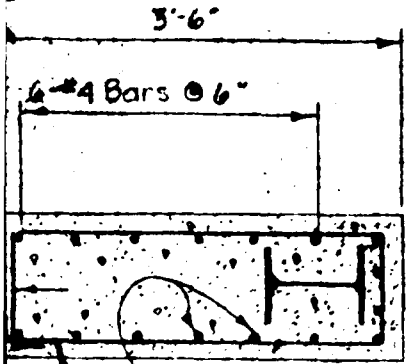
**STRUT SECTION**  
 Scale:  $\frac{3}{4}$ " = 1'-0"

**ELEVATION SECTION**  
 0"

#4 or #6 Vertical Bars  
 #4 Bars @ 15"

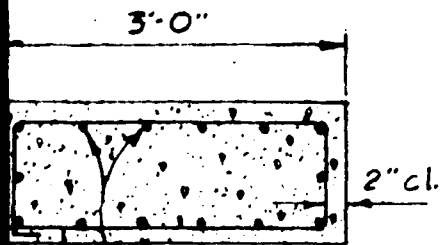
#4 Bars @ 15" Extend a minimum of 2'-0" beyond each side of stoplog slot





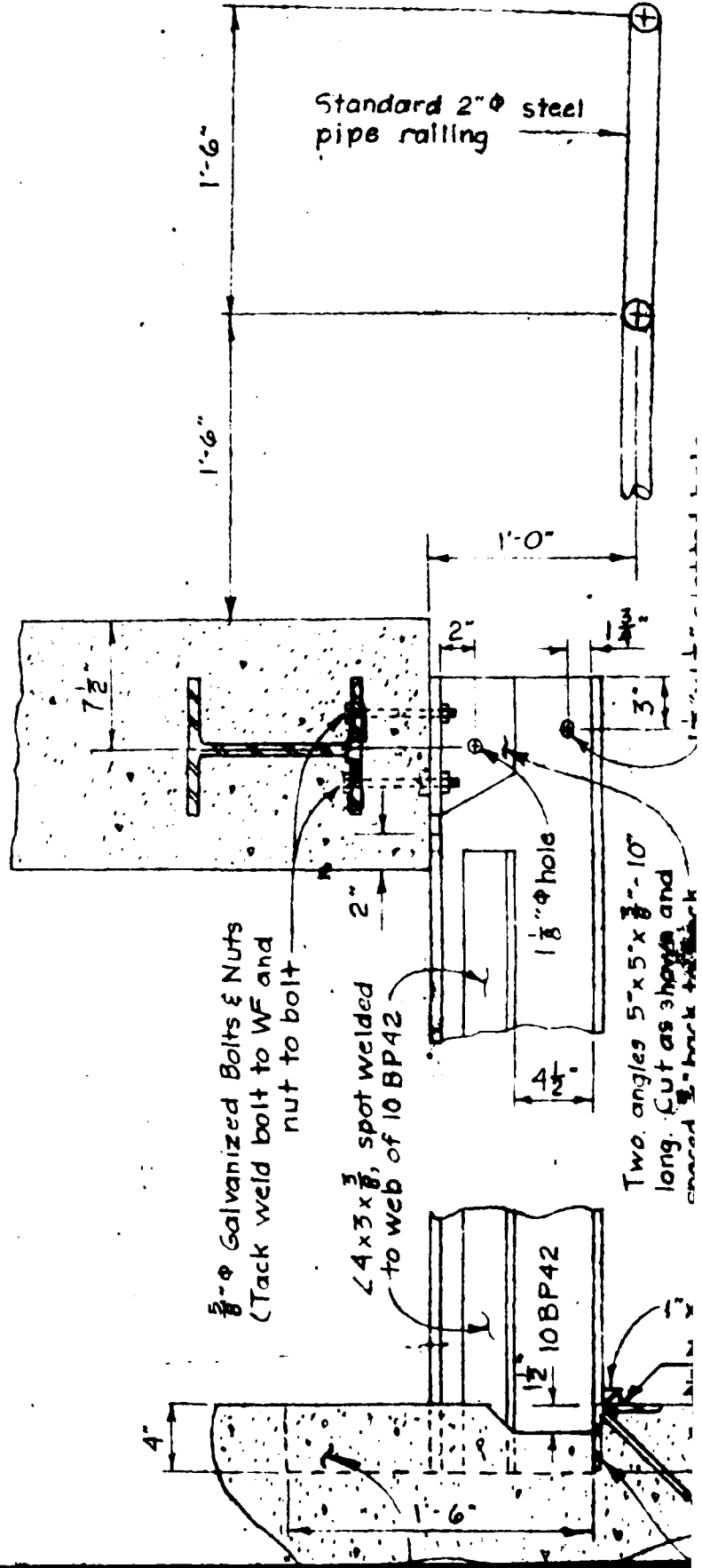
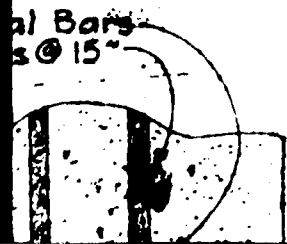
**SIDEWALK SECTION**

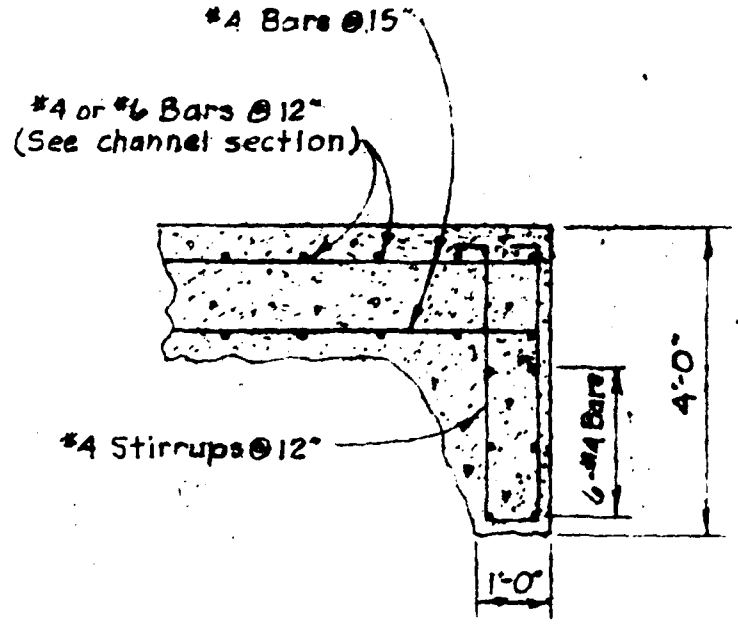
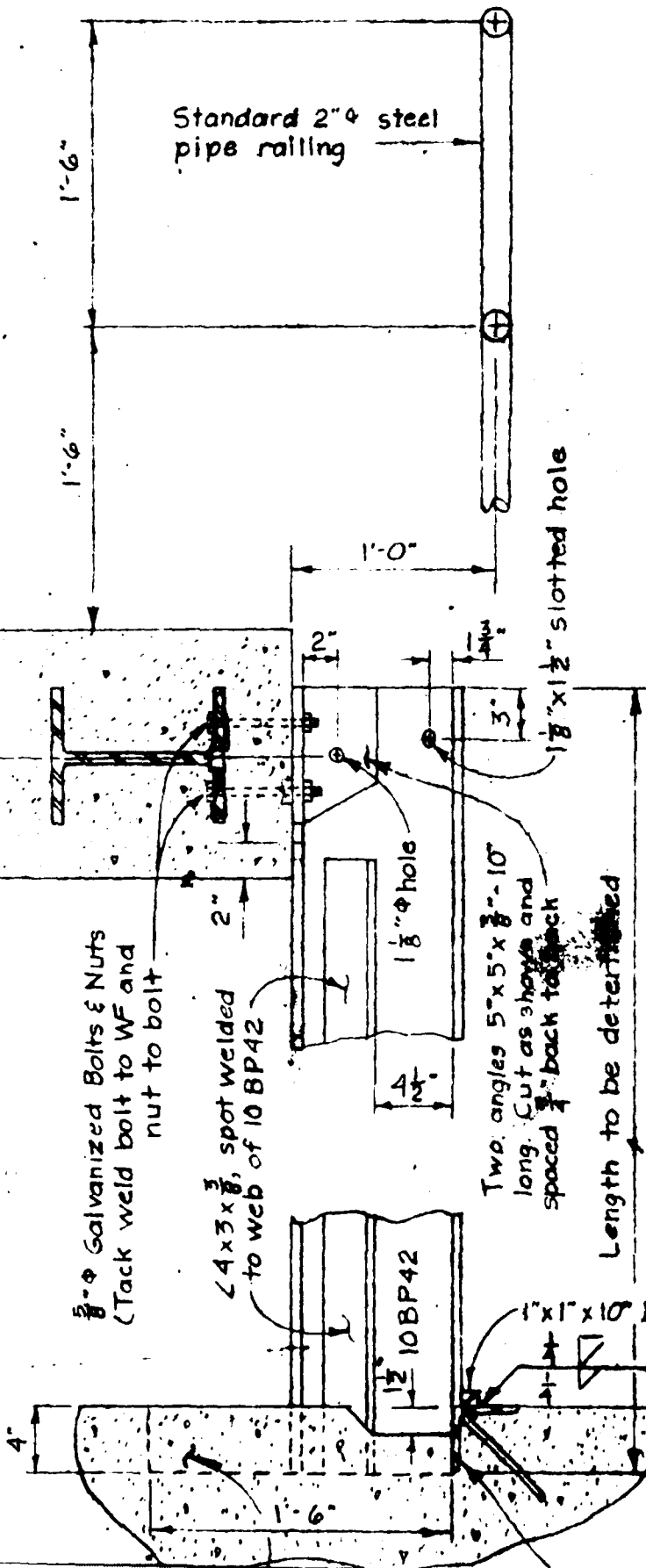
Scale:  $\frac{3}{4}'' = 1'-0''$



**STRUT SECTION**

Scale:  $\frac{3}{4}'' = 1'-0''$





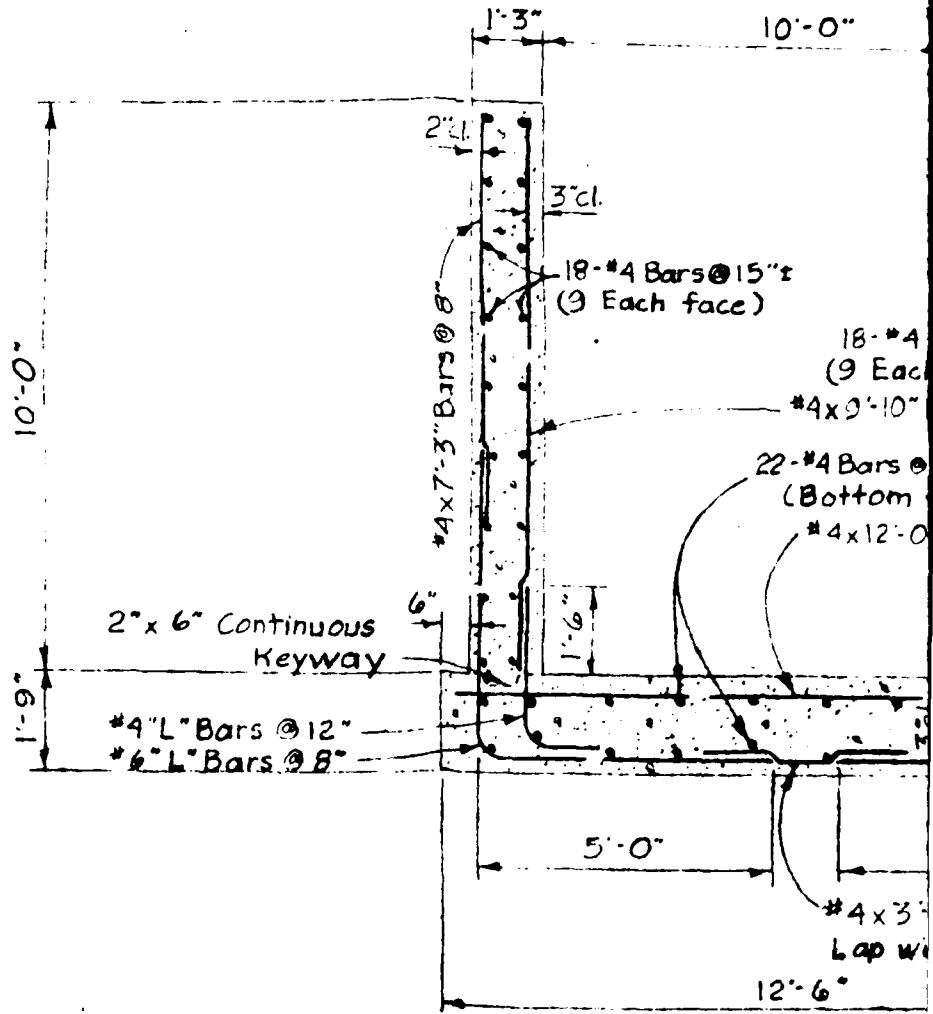
TYPICAL UPSTREAM AND DOWNSTREAM CUT OFF WALL

Scale: 1/2" = 1'-0"

\*6 Reinforcing bar 1'-0" Long, Weld to angle  $\phi$  18"

TYPICAL CHANNEL

Scale:  $\frac{3}{8}$ " = 1'-0"



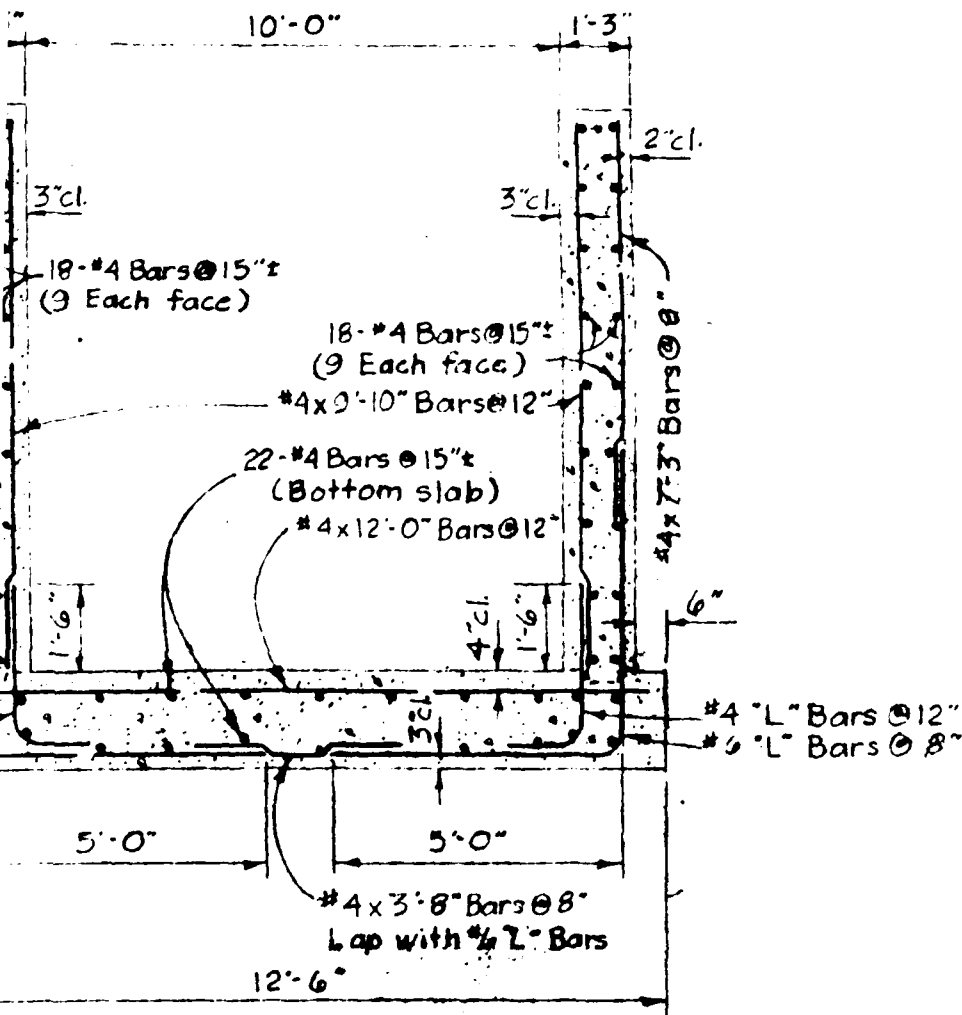
OPTIONAL CHANNEL

Scale:  $\frac{3}{8}$ " = 1'-0"

|             |                 |
|-------------|-----------------|
| Designed by | D.M.R.          |
| Drawn by    | D.M.R.          |
| Traced by   |                 |
| Checked by  | Francis C. Howe |

# TYPICAL CHANNEL SECTION

Scale:  $\frac{3}{8}$ " = 1'-0"



\*4 or \*6 Vertical  
\*4 Bar

\*4 Bars @ 15" Extend a minimum of 2'-0" beyond each side of stoplog slot

\*6 Reinforcing bar 1'-0" Long, Weld to L @ 18" c.-c.

\*This dim Adjust if is used.

TYP

NOTE:  
4 Shaft of be smooth

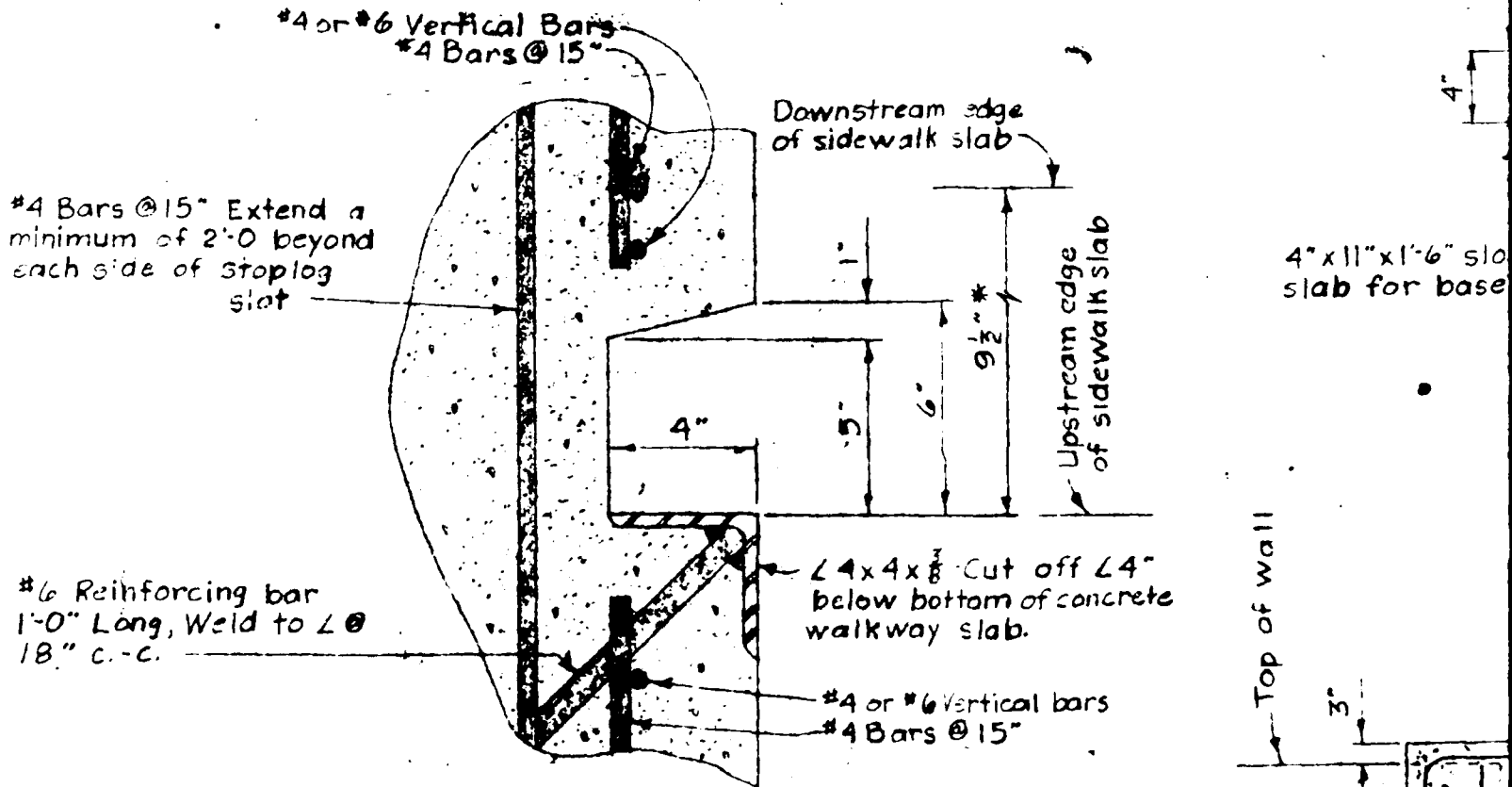
# OPTIONAL CHANNEL SECTION

Scale:  $\frac{3}{8}$ " = 1'-0"

14-#6 Bars Place as shown  
#4 Ties @ 12"

**STRUT SECTION**

Scale:  $\frac{3}{4}$ " = 1'-0"



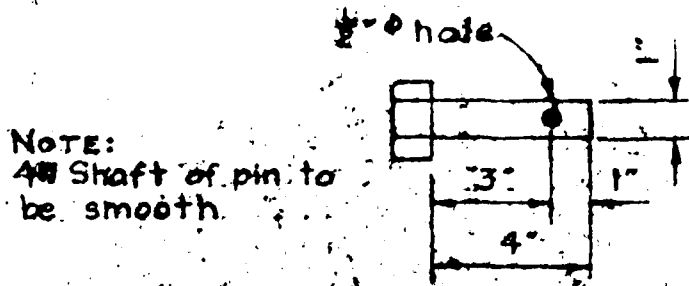
#4 Bars @ 15" Extend a minimum of 2'-0" beyond each side of stoplog slot

#6 Reinforcing bar 1'-0" Long, Weld to L @ 18" c.-c.

\*This dimension is based on a 10BP42. Adjust if other size stanchion beam is used.

#6 "L" Bars @ 9'; 8'-0" Long, 4'-0" legs

**TYPICAL STOPLOG SLOT**



NOTE: Shaft of pin to be smooth.

NOTE: Reinforcing Steel in or strut not shown.

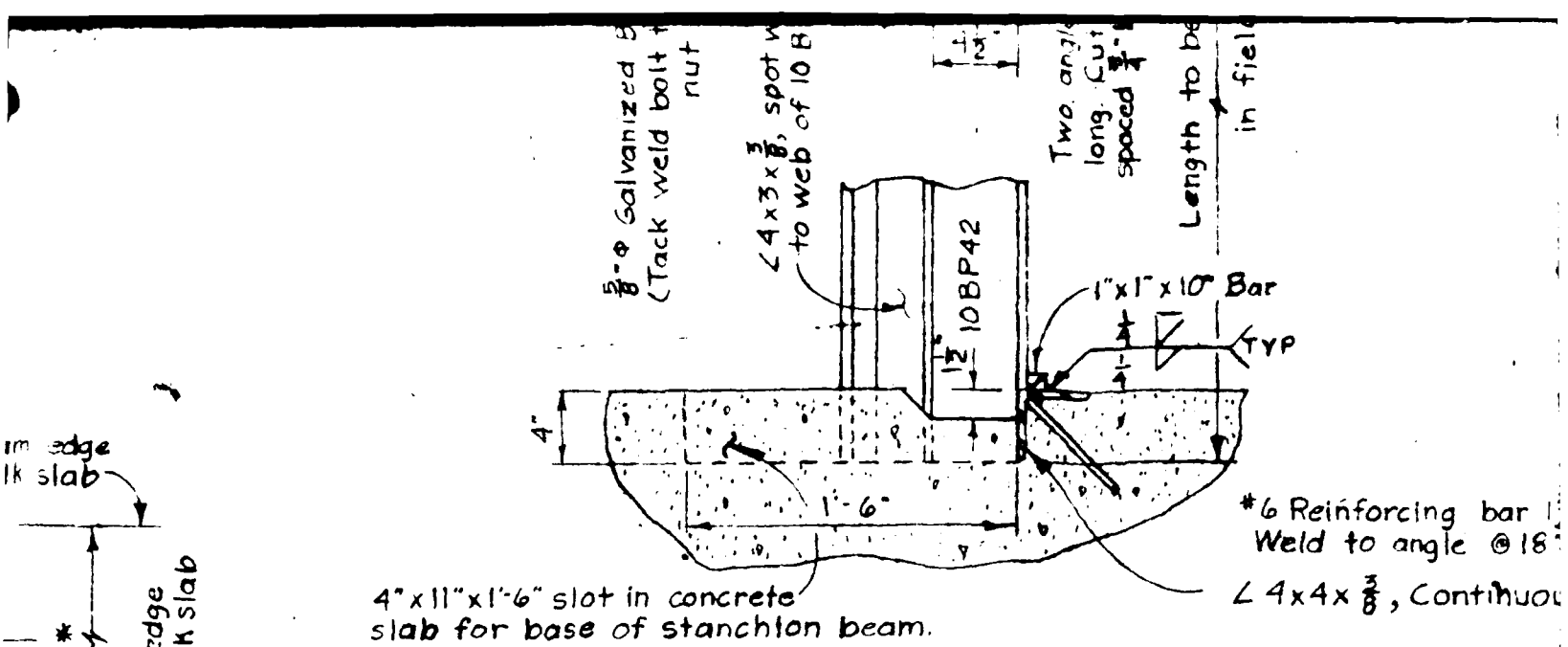
**LOCKING PIN DETAIL**

Scale: 3" = 1'-0"

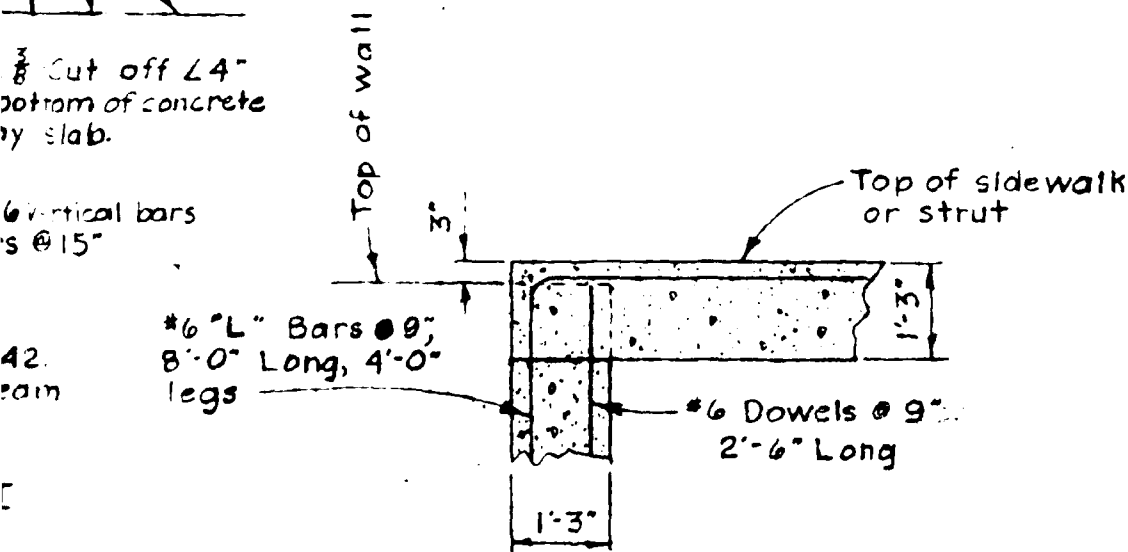
**SECTION A OR ST**

Scale: 1/2" = 1'-0"





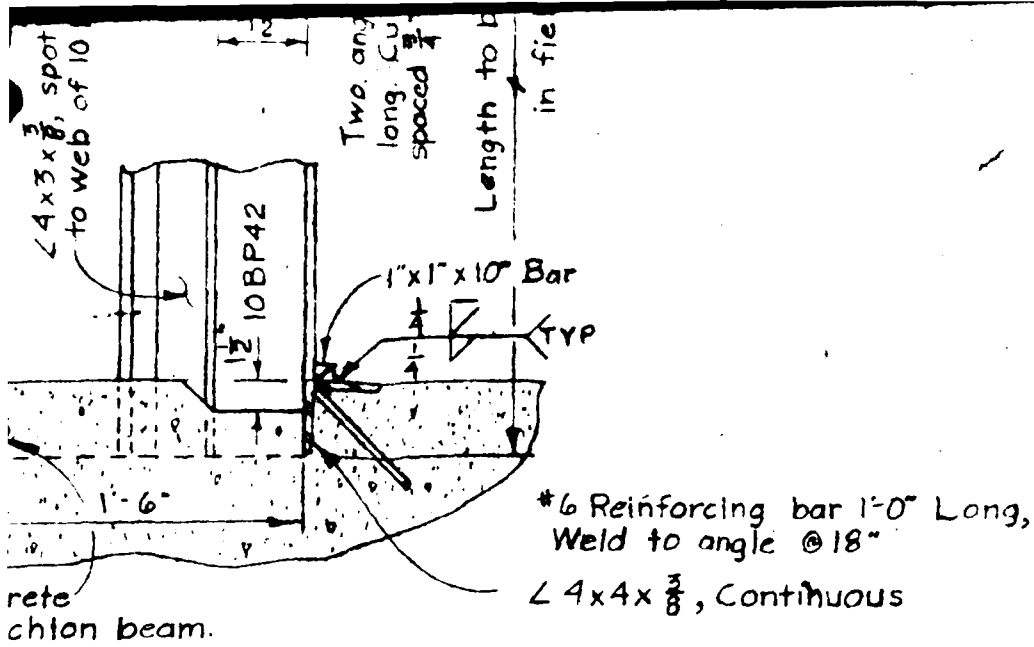
• TYPICAL STANCHION BEAM  
Scale: 1 1/2" = 1'-0"



NOTE:  
Reinforcing Steel in sidewalk or strut not shown.

SECTION AT SIDEWALK OR STRUT  
Scale: 1/2" = 1'-0"

|   |       |
|---|-------|
| Northwood <del>XXXXXXXXXX</del> L           |       |
| Epsom <del>XXXXXXXXXX</del> , NH            |       |
| TYPICAL                                     |       |
| <b>NEW HAMPSHIRE WATER CONTROL DISTRICT</b> |       |
| CONCRETE                                    |       |
| Sheet Scale:<br>As noted                    | Sheet |



AL STANCHION BEAM

Scale:  $1 \frac{1}{2}" = 1'-0"$

Top of sidewalk or strut



owels @ 9"  
6" Long

DWG. NO. 3

WALK

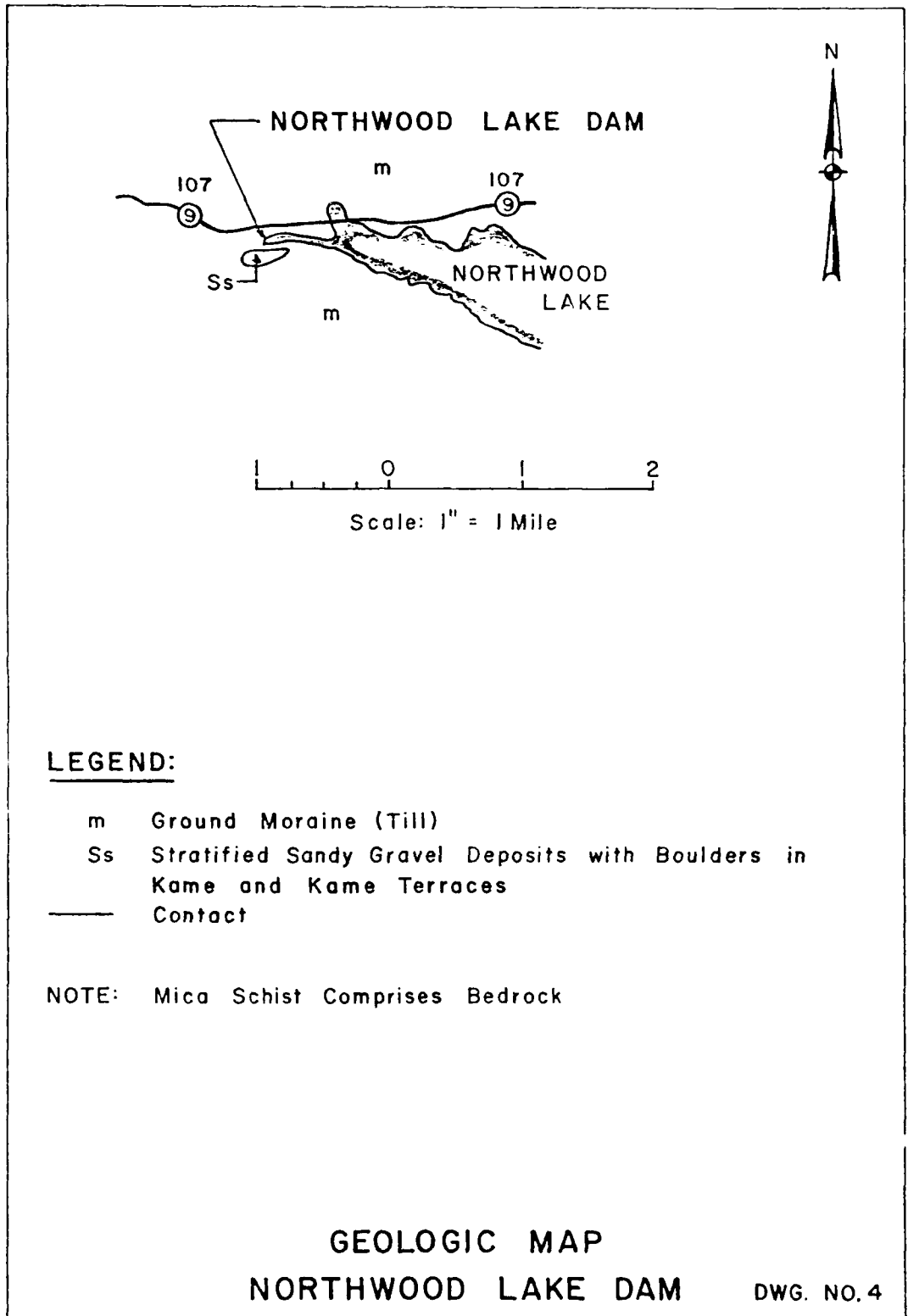
Northwood ~~LAKE~~ LAKE DAM  
 Epsom ~~LAKE~~, NEW HAMPSHIRE  
 TYPICAL SECTIONS

**NEW HAMPSHIRE WATER RESOURCES BOARD**  
 - CONCORD, N. H. -

Sheet Scale:  
As noted "

Sheet 2 of 2

JULY 1972



**LEGEND:**

- m Ground Moraine (Till)
- Ss Stratified Sandy Gravel Deposits with Boulders in Kame and Kame Terraces
- Contact

NOTE: Mica Schist Comprises Bedrock

**GEOLOGIC MAP  
NORTHWOOD LAKE DAM**

DWG. NO. 4

APPENDIX D

HYDROLOGIC COMPUTATIONS

# DAM SAFETY INSPECTION

NEW HAMPSHIRE - NORTHWOOD LAKE DAM

HYDROHYDRAULICS / PMP

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

JOB NO. 1211

BY YIN DATE Jan

## Maximum Probable Flood Peak Flow Rate

According to NED General Curve

Assume FLAT & COASTAL region

$$Q = 1020.84 - 304.91 \log_{10} A$$

$$A = 20.7 \text{ sq mile}$$

$$Q = 619.6 \text{ cfs/sq mile}$$

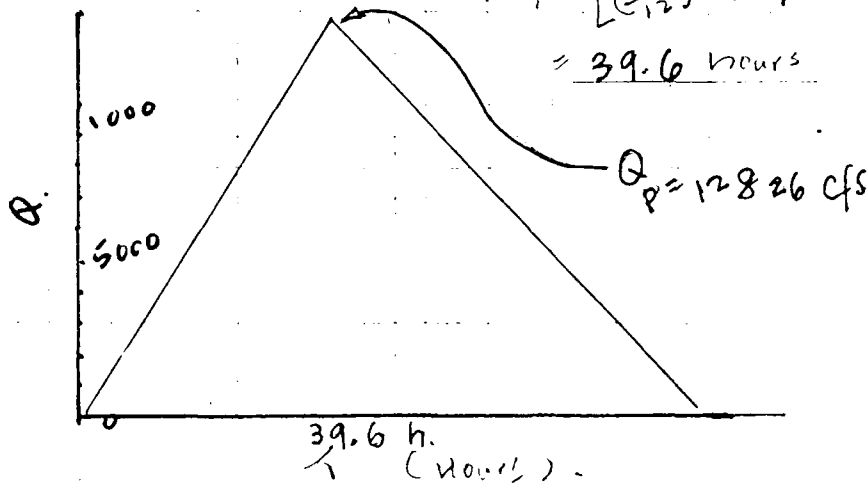
$$Q_p = A \times Q = 20.7 \times 619.6 = 12,826 \text{ cfs}$$

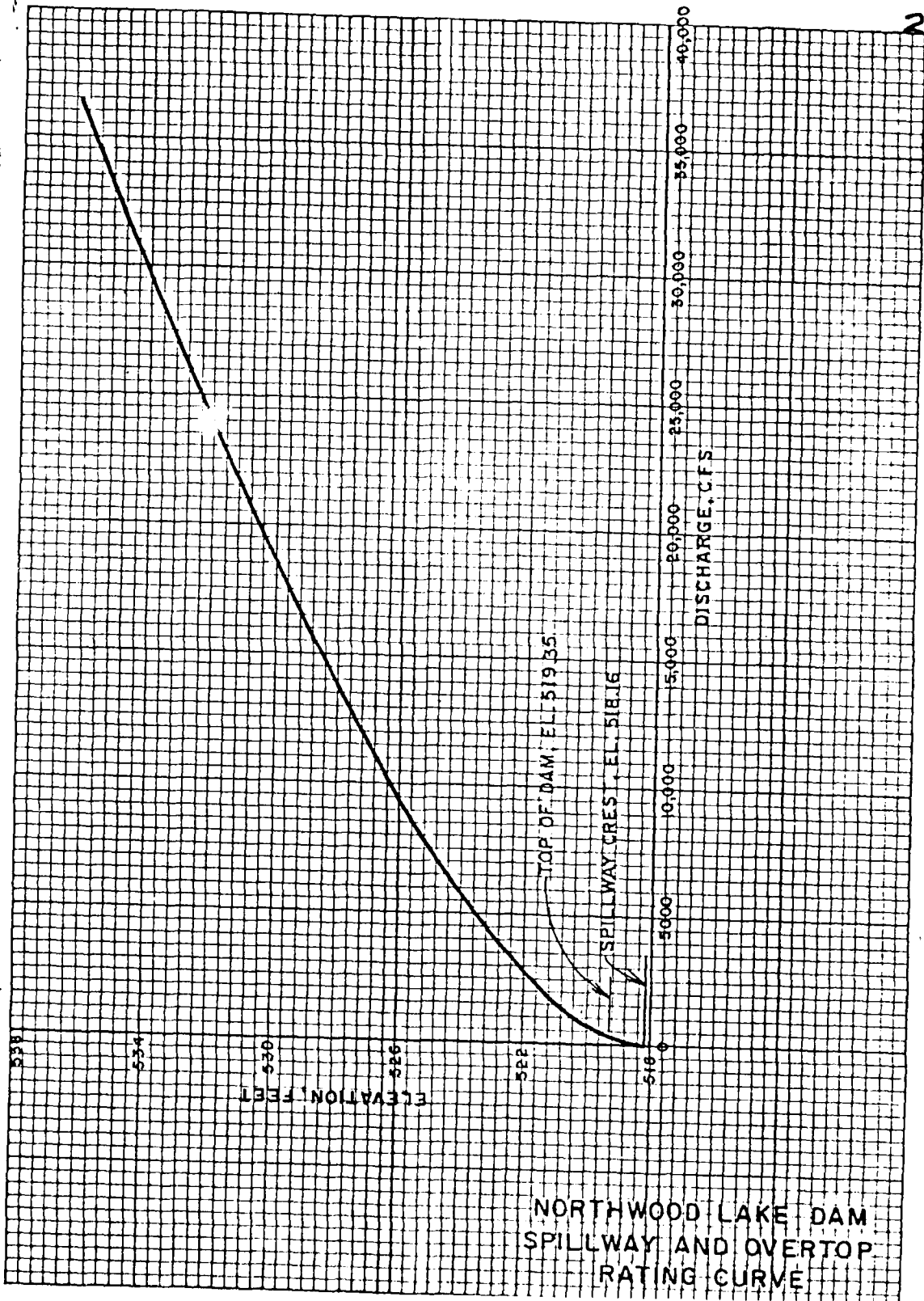
Since MPF runoff in New England equals approx 19" according to NED guideline

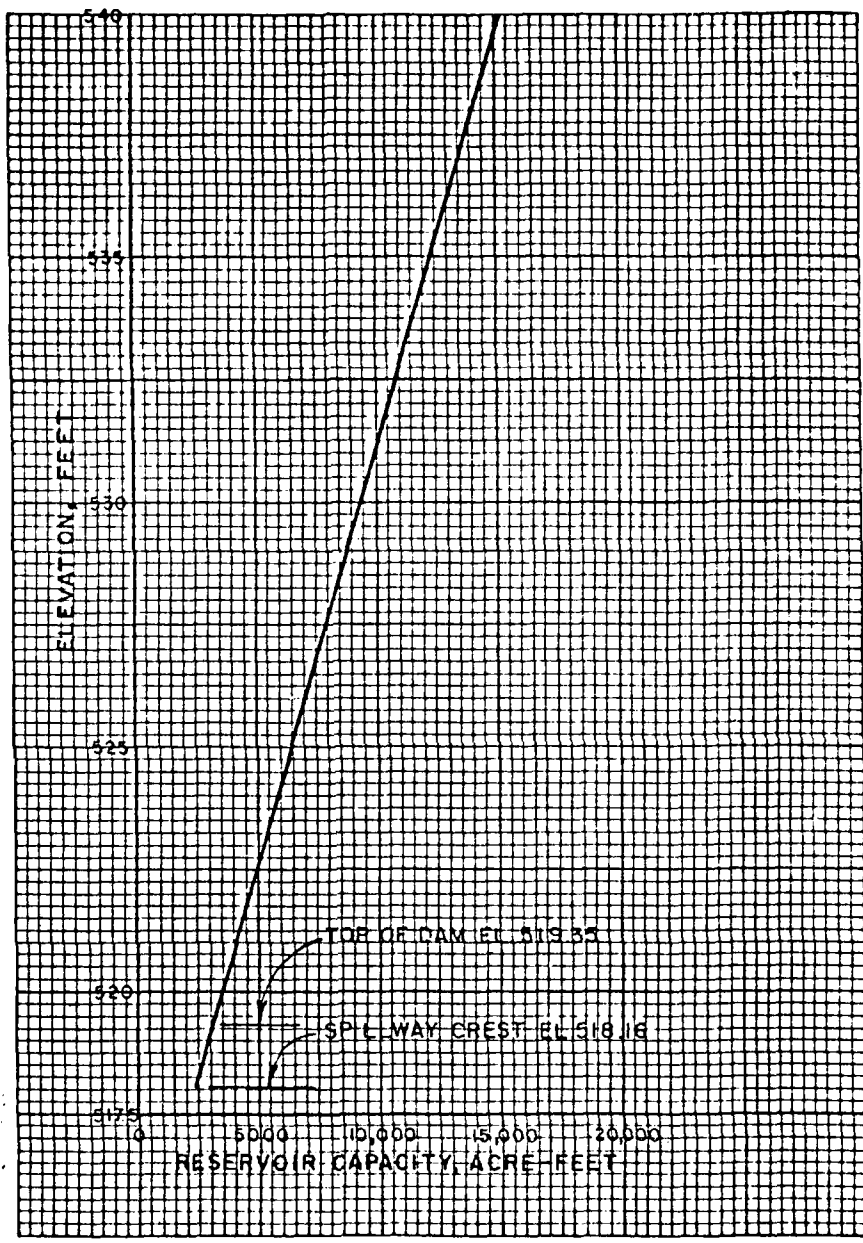
the triangular hydrograph will be approximate to following shape:  $\frac{1}{2} T \times Q_p = 19" \times A$

$$T = \left[ \left( \frac{19}{12} \right) \times 20.7 \times 27,872,800 \right] / 136$$

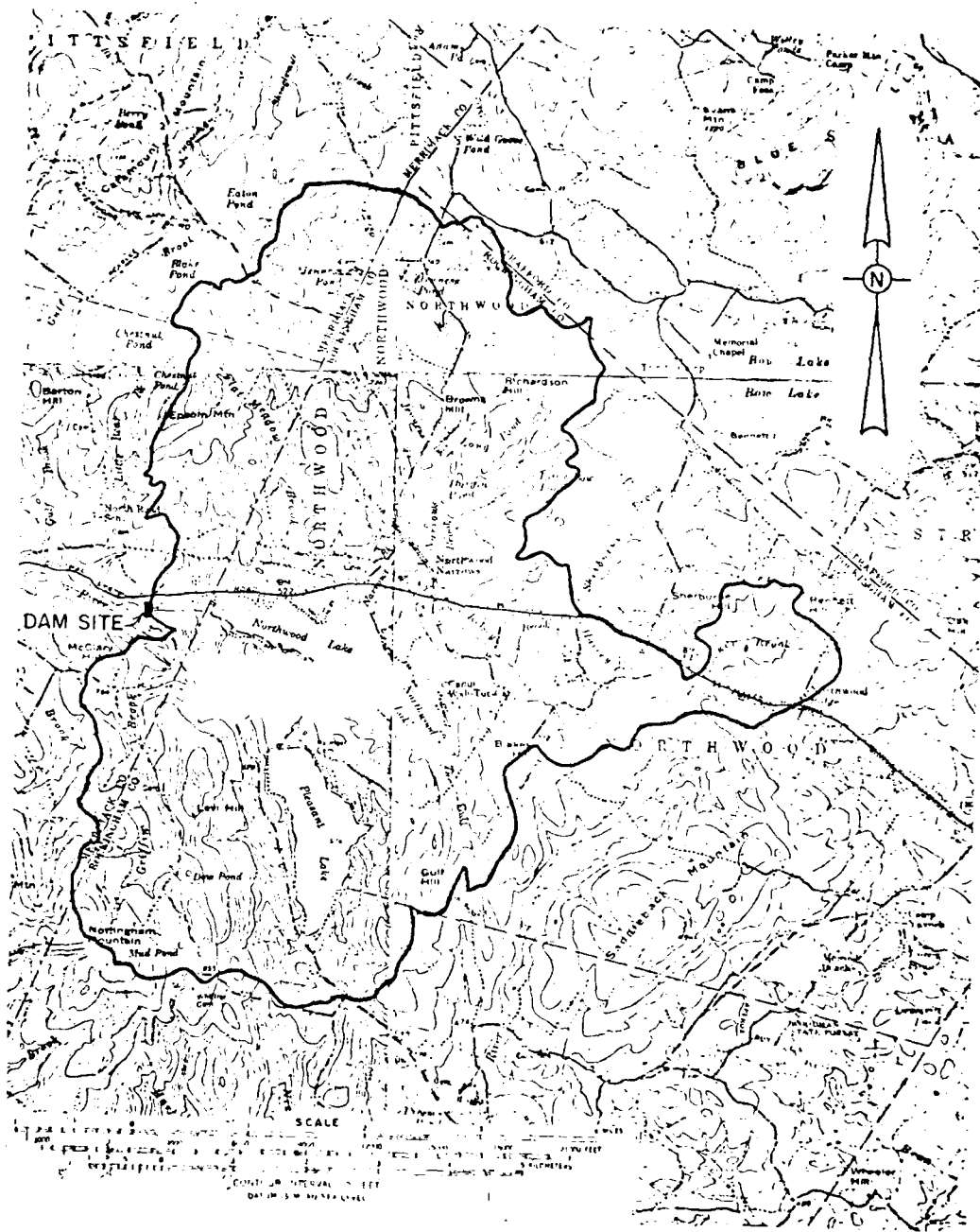
$$= 39.6 \text{ hours}$$







NORTHWOOD LAKE DAM  
RESERVOIR CAPACITY CURVE



NORTHWOOD LAKE DAM  
DRAINAGE BASIN



NORTHWOOD LAKE DAM

STUDY OF THE EFFECTS OF DAM FAILURE

Step 1: Determine Surge Height and SPMF:

$$SPMF = 12,828 \text{ cfs}$$

$$\text{Surge SPMF (HEC-1)} = 10,970 \text{ cfs}$$

Surge Height (above Stillwater Level)

$$\text{for } 10,970 \text{ cfs} = 525.76 - 518.16$$

$$= \underline{7.60 \text{ ft}} \text{ (from Stillwater \& Overtopping Fringe Curve)}$$

Step 2: Determine Peak Failure Outflow  $Q_p$ :

$$Q_p = \frac{8}{27} W_b \sqrt{2g} Y_0^{3/2}$$

$W_b = 0.40 \times \text{dam length across river}$   
at mid height at SPMF

$$= 0.40 \times 169'$$

$$= 67.60 \text{ ft}$$

$Y_0 = \text{Total height from river bed}$   
to pool level at failure

= Height top of dam to bed of  
Stream

$$= 14.3 \text{ ft}$$

NEW HAVEN DAM STAGE DISCHARGE CURVES SHEET NO. 2 OF 2  
 HARTFORD LAKE DAM JOB NO. 1211-001  
 DAM NUMBER 27032 BY JAS DATE 1/22

$$Q_p = \frac{9}{27} (67.60) \sqrt{64.4} (14.3)^{3/2}$$

$$= 9250 \text{ cfs}$$

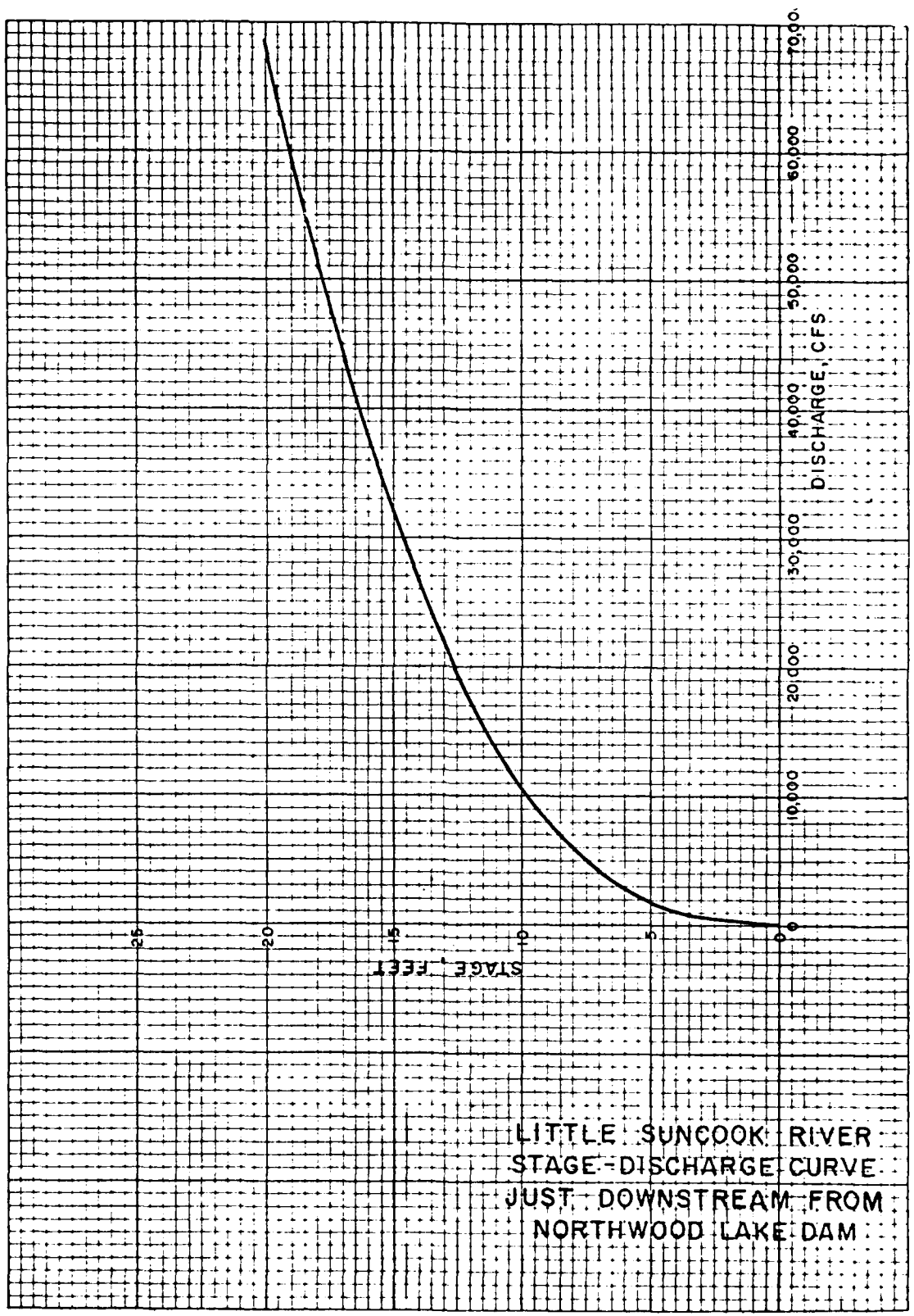
Step 3: Develop stage discharge curves for the downstream channel. Assumptions and procedures are same as for Stinson Lake Dam.

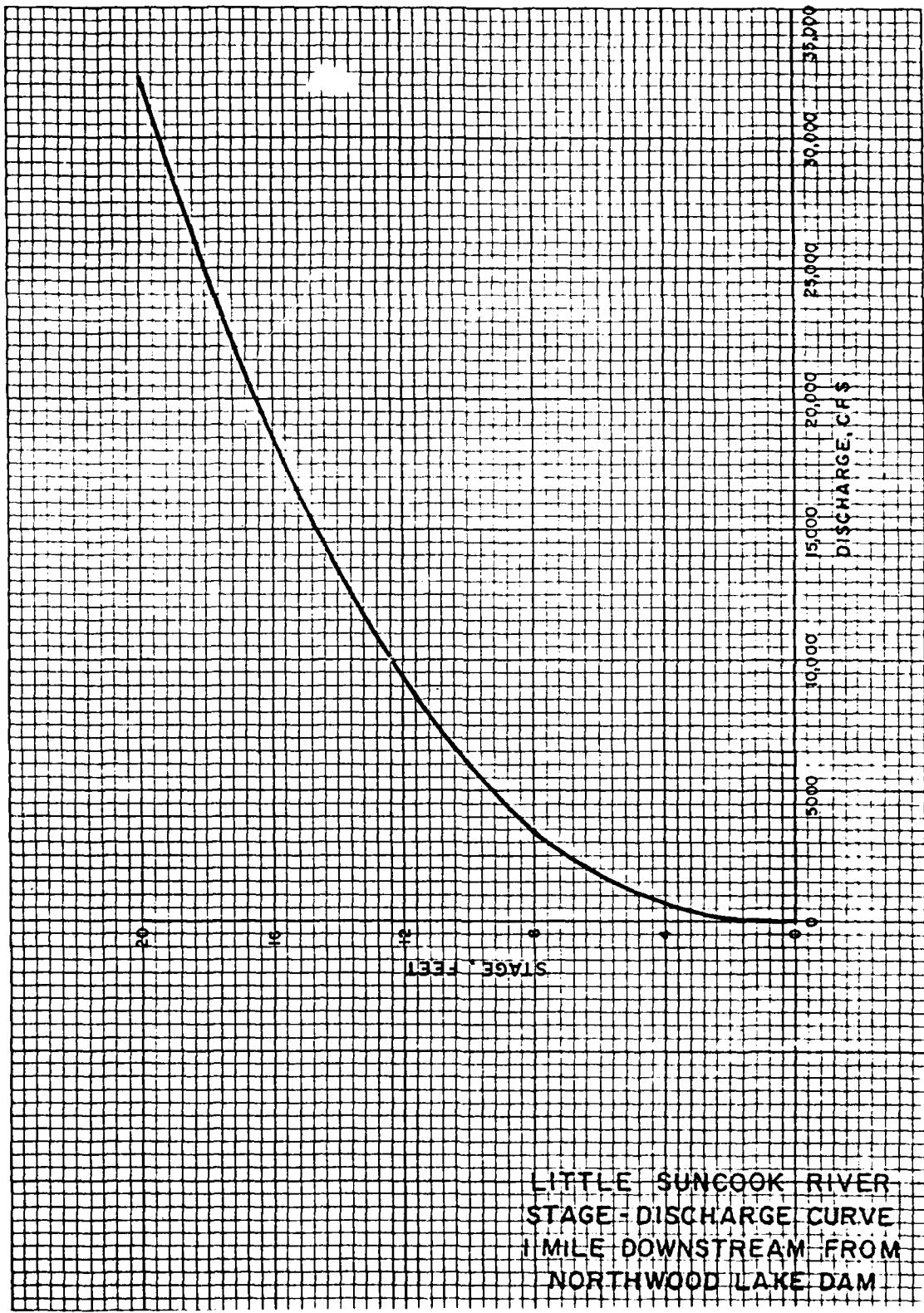
The stage discharge curves are on page 3 through 6.

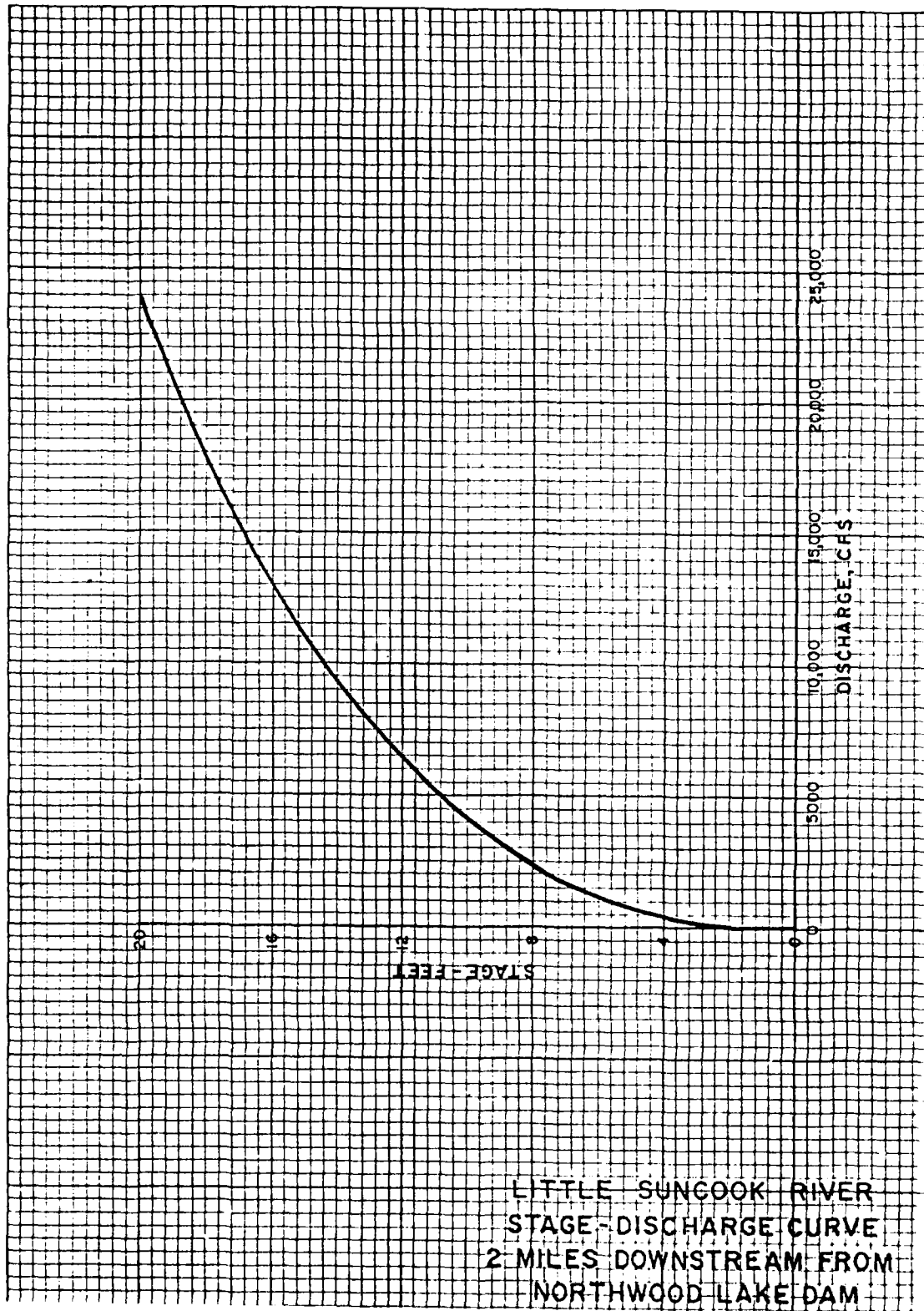
Step 4: Determine stage corresponding to  $Q_p$  at each section (assumptions are same as for Stinson Lake Dam).

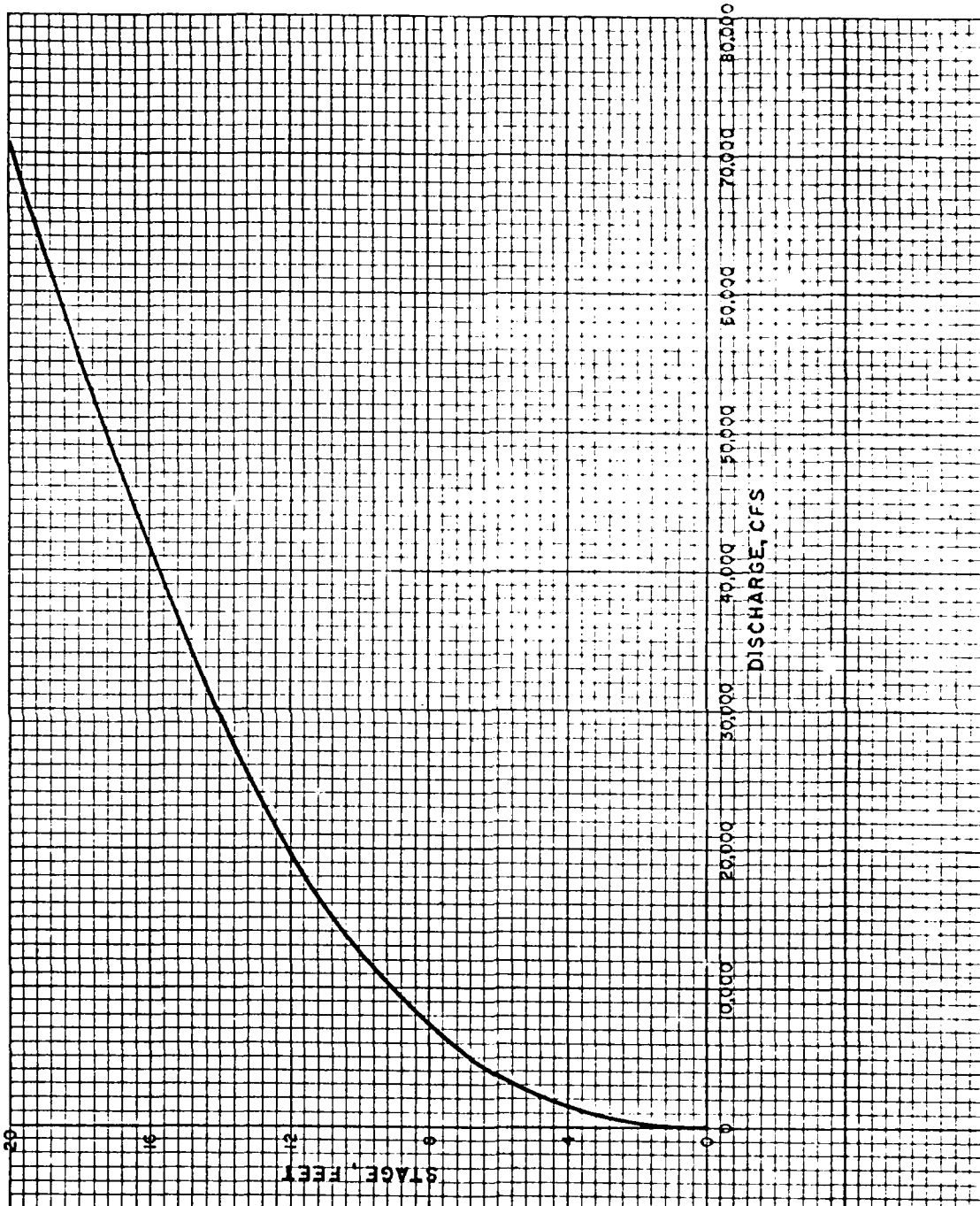
Peak Discharge  $Q_p = 9250 \text{ cfs}$

|                                     |     |      |      |     |
|-------------------------------------|-----|------|------|-----|
| Distance downstream from Dam, miles | 0   | 1    | 2    | 3   |
| Stage, Feet                         | 9.2 | 12.0 | 14.0 | 8.5 |









LITTLE SUNCOOK RIVER  
STAGE-DISCHARGE CURVE  
3 MILES DOWNSTREAM FROM  
NORTHWOOD LAKE DAM

ENGINEERING CONSULTANTS, INC.

NEW HAMPSHIRE DAM SAFETY INSPECTION SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_  
 NORTHWOOD LAKE DAM JOB NO. 1211-CM1  
 STAGE-DISCHARGE RELATIONS AT DAM SITE BY MMS DATE 7/3/78

Assume  $n' = 0.10$   
 Slope,  $S = \frac{300 - 440}{5230} = 0.0114 \text{ ft/ft}$   
 Discharge:  $Q = \frac{1.49}{n} AR^{2/3} S^{1/2} = \frac{1.49}{.1} AR^{2/3} (.0114)^{1/2}$   
 $= 1.59 AR^{2/3}$

| Stage<br>ft. | Area<br>A<br>Sq. ft. | Wetted<br>Perimeter<br>P<br>ft. | Hydraulic<br>Radius<br>R<br>ft. | $AR^{2/3}$ | $Q = 1.59 AR^{2/3}$<br>cfs |
|--------------|----------------------|---------------------------------|---------------------------------|------------|----------------------------|
| 0            | 0                    | 0                               | 0                               | 0          | 0                          |
| 4            | 368                  | 184'                            | 2                               | 586        | 932                        |
| 8            | 1472                 | 368                             | 4                               | 3726       | 5924                       |
| 12           | 3312                 | 552                             | 6                               | 11002      | 17493                      |
| 16           | 5888                 | 736                             | 8                               | 23716      | 37708                      |
| 20           | 9200                 | 920                             | 10                              | 43032      | 68421                      |

ENGINEERING CONSULTANTS, INC.

New Hampshire Dam Safety Inspection  
 Notched Lake Dam

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

JOB NO. 1211-001

RATING CURVE OF DOWNSTREAM CHANNEL

BY M.R.H. DATE 6/29/72

| Stage<br>ft. | Area<br>A<br>Sq. ft. | Wetted<br>Perimeter<br>W.P.<br>ft. | Hydraulic<br>Radius<br>R<br>ft. | $AR^{4/3}$ | $Q = \frac{1.49}{n} AR^{3/2}$<br>$Q = 1.16 AR^{3/2}$<br>cu. ft./sec. |
|--------------|----------------------|------------------------------------|---------------------------------|------------|--|
| 0            | 0                    | 0                                  | 0                               | 0          | 0  |
| 4            | 300                  | 150                                | 2                               | 476        | 550  |
| 8            | 1160                 | 290                                | 4                               | 2923       | 3390   |
| 12           | 2520                 | 420                                | 6                               | 8321       | 9650   |
| 16           | 4080                 | 510                                | 8                               | 16321      | 18730  |
| 20           | 6000                 | 600                                | 10                              | 27852      | 32310  |

Channel slope,  $S = 40 / (1,351,5230) = 0.00296$  ft./ft.

$n = 0.1$

Stage - discharge curve is for 1 mile downstream.



ENGINEERING CONSULTANTS, INC.

New Hampshire Dam Safety Inspection

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

Northwood Lake Dam

JOB NO. 1211-001

RATING CURVE OF DOWNSTREAM CHANNEL

BY M.P.H. DATE 4/29/72

| Stage<br>ft. | Area<br>A<br>sq. ft. | Wetted<br>Perimeter<br>W.P.<br>ft. | Hydraulic<br>Radius<br>R<br>ft. | $AR^{2/3}$ | $Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$<br>$Q = 1.49 \frac{AR^{2/3}}{n} S^{1/2}$ |
|--------------|----------------------|------------------------------------|---------------------------------|------------|--|
| 0            | 0                    | 0                                  | 0                               | 0          | 0  |
| 4            | 210                  | 105                                | 2                               | 333        | 470  |
| 8            | 660                  | 165                                | 4                               | 1663       | 2370   |
| 12           | 1380                 | 230                                | 6                               | 4557       | 6410   |
| 16           | 2320                 | 290                                | 8                               | 7281       | 13050  |
| 20           | 3650                 | 365                                | 10                              | 16743      | 23820  |

Channel slope,  $S = 40' / (352.5282) = 0.1135$

$n = 0.10$

Stage - Discharge Curve is for 5 miles Downstream

ENGINEERING CONSULTANTS, INC.

New Hampshire Dam Safety Inspection

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

Northwood Lake Dam

JOB NO. 1211-001

RATING CURVE OF DOWNSTREAM CHANNEL

BY H.P.H. DATE 4/23/78

| Stage<br>H. | Area<br>A<br>sq. ft. | Wetted<br>Perimeter<br>W.P.<br>ft. | Hydraulic<br>Radius<br>R<br>ft. | $K.P. \frac{A}{P^2}$ | $Q = \frac{1.49}{n} A R^{4/3} S^{1/2}$<br>$P = 1.55 A R^{2/3}$<br>cu ft/sec |
|-------------|----------------------|------------------------------------|---------------------------------|----------------------|---|
| 0           | 0                    | 0                                  | -                               | 0                    | 0   |
| 4           | 500                  | 250                                | 2                               | 794                  | 1230  |
| 5           | 1820                 | 455                                | 4                               | 4586                 | 7110  |
| 12          | 3900                 | 650                                | 6                               | 12878                | 19960   |
| 15          | 6600                 | 825                                | 8                               | 26400                | 46920   |
| 20          | 9800                 | 980                                | 10                              | 45490                | 70510   |

channel slope,  $s = 10 / (10,715.33) = 0.00093$

$n = 0.1$

Stage - Discharge curve is for 3 miles downstream.

AD-A156 413

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS  
NORTHWOOD LAKE DAM (N. 10) CORPS OF ENGINEERS WALTHAM  
MA NEW ENGLAND DIV OCT 78

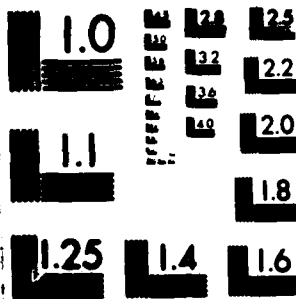
2/2

UNCLASSIFIED

F/2 13/13 ML



END  
DATE  
FILMED  
8 '85



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

111

HEC 1 - COMPUTATIONS





|     |       |    |       |
|-----|-------|----|-------|
| 47  | 3756. | 0. | 1356. |
| 48  | 3639. | 0. | 1125. |
| 49  | 3551. | 0. | 1085. |
| 50  | 3472. | 0. | 896.  |
| 51  | 3402. | 0. | 803.  |
| 52  | 3326. | 0. | 796.  |
| 53  | 3278. | 0. | 782.  |
| 54  | 3222. | 0. | 657.  |
| 55  | 3167. | 0. | 615.  |
| 56  | 3120. | 0. | 576.  |
| 57  | 3074. | 0. | 539.  |
| 58  | 3030. | 0. | 504.  |
| 59  | 2990. | 0. | 472.  |
| 60  | 2952. | 0. | 442.  |
| 61  | 2917. | 0. | 413.  |
| 62  | 2884. | 0. | 387.  |
| 63  | 2853. | 0. | 362.  |
| 64  | 2824. | 0. | 339.  |
| 65  | 2797. | 0. | 317.  |
| 66  | 2771. | 0. | 297.  |
| 67  | 2747. | 0. | 278.  |
| 68  | 2725. | 0. | 260.  |
| 69  | 2704. | 0. | 243.  |
| 70  | 2685. | 0. | 228.  |
| 71  | 2667. | 0. | 213.  |
| 72  | 2650. | 0. | 199.  |
| 73  | 2635. | 0. | 187.  |
| 74  | 2618. | 0. | 175.  |
| 75  | 2604. | 0. | 163.  |
| 76  | 2591. | 0. | 153.  |
| 77  | 2579. | 0. | 143.  |
| 78  | 2568. | 0. | 134.  |
| 79  | 2557. | 0. | 125.  |
| 80  | 2547. | 0. | 117.  |
| 81  | 2537. | 0. | 110.  |
| 82  | 2529. | 0. | 103.  |
| 83  | 2520. | 0. | 96.   |
| 84  | 2513. | 0. | 90.   |
| 85  | 2505. | 0. | 84.   |
| 86  | 2499. | 0. | 79.   |
| 87  | 2492. | 0. | 74.   |
| 88  | 2486. | 0. | 69.   |
| 89  | 2481. | 0. | 64.   |
| 90  | 2476. | 0. | 60.   |
| 91  | 2471. | 0. | 56.   |
| 92  | 2466. | 0. | 53.   |
| 93  | 2462. | 0. | 49.   |
| 94  | 2458. | 0. | 46.   |
| 95  | 2454. | 0. | 43.   |
| 96  | 2451. | 0. | 40.   |
| 97  | 2447. | 0. | 38.   |
| 98  | 2444. | 0. | 35.   |
| 99  | 2441. | 0. | 33.   |
| 100 | 2439. | 0. | 31.   |
| 101 | 2436. | 0. | 29.   |
| 102 | 2434. | 0. | 27.   |
| 103 | 2432. | 0. | 25.   |
| 104 | 2430. | 0. | 24.   |
| 105 | 2428. | 0. | 22.   |
| 106 | 2426. | 0. | 21.   |
| 107 | 2424. | 0. | 19.   |

1940-1941



| 100 | 2425. | 0.     | 10. |
|-----|-------|--------|-----|
| 109 | 2421. | 0.     | 17. |
| 110 | 2420. | 0.     | 16. |
| 111 | 2416. | 0.     | 15. |
| 112 | 2417. | 0.     | 14. |
| 113 | 2416. | 0.     | 13. |
| 114 | 2415. | 0.     | 12. |
| 115 | 2414. | 0.     | 11. |
| 116 | 2413. | 0.     | 10. |
| 117 | 2412. | 0.     | 10. |
| 118 | 2411. | 0.     | 9.  |
| 119 | 2411. | 0.     | 8.  |
| 120 | 2410. | 0.     | 8.  |
| 121 | 2409. | 0.     | 7.  |
| 122 | 2409. | 0.     | 7.  |
| 123 | 2408. | 0.     | 6.  |
| 124 | 2408. | 0.     | 6.  |
| 125 | 2407. | 0.     | 6.  |
| 126 | 2407. | 0.     | 5.  |
| 127 | 2406. | 0.     | 5.  |
| 128 | 2406. | 0.     | 4.  |
| 129 | 2405. | 0.     | 4.  |
| 130 | 2405. | 0.     | 4.  |
| 131 | 2405. | 0.     | 4.  |
| 132 | 2404. | 0.     | 3.  |
| 133 | 2404. | 0.     | 3.  |
| 134 | 2404. | 0.     | 3.  |
| 135 | 2403. | 0.     | 3.  |
| 136 | 2403. | 0.     | 2.  |
| 137 | 2403. | 0.     | 2.  |
| 138 | 2403. | 0.     | 2.  |
| 139 | 2402. | 0.     | 2.  |
| 140 | 2402. | 0.     | 2.  |
| 141 | 2402. | 0.     | 2.  |
| 142 | 2402. | 0.     | 1.  |
| 143 | 2402. | 0.     | 1.  |
| 144 | 2402. | 0.     | 1.  |
| 145 | 2401. | 0.     | 1.  |
| 146 | 2401. | 0.     | 1.  |
| 147 | 2401. | 0.     | 1.  |
| 148 | 2401. | 0.     | 1.  |
| 149 | 2401. | 0.     | 1.  |
| 150 | 2401. | 0.     | 1.  |
| SUM |       | 25650. |     |

PEAK 10070.  
 CFS 16623.  
 INCHES 4.77  
 AC-FY 5270.  
 6-HOUR 8295.  
 24-HOUR 14.91  
 72-HOUR 19.02  
 TOTAL VOLUME 256500.  
 19.24  
 21209.

BENTON  
 THE BENTON COMPANY  
 1000 CENTRAL AVENUE, INDIANAPOLIS, INDIANA 46202

11 11

RUNOFF SUMMARY: AVERAGE FLOW

| HYDROGRAPH AT | PEAK   | 6-HOUR | 24-HOUR | 72-HOUR | AREA  |
|---------------|--------|--------|---------|---------|-------|
| 1             | 12826. | 11590. | 8984.   | 5562.   | 20.78 |
| 1             | 10870. | 10623. | 8295.   | 3527.   | 20.78 |



UNIT SOUTH NAVAL DISTRICT, CORP DISTRICT 110271





|    |       |       |       |
|----|-------|-------|-------|
| 25 | 5558. | 4409. | 4856. |
| 26 | 3506. | 4141. | 4691. |
| 27 | 5446. | 3674. | 4520. |
| 28 | 5378. | 3607. | 4330. |
| 29 | 5305. | 3540. | 4123. |
| 30 | 5227. | 3473. | 3904. |
| 31 | 5146. | 3405. | 3675. |
| 32 | 5061. | 3338. | 3438. |
| 33 | 4975. | 3271. | 3194. |
| 34 | 4887. | 3204. | 2946. |
| 35 | 4797. | 3136. | 2696. |
| 36 | 4701. | 3066. | 2566. |
| 37 | 4594. | 2991. | 2421. |
| 38 | 4478. | 2919. | 2263. |
| 39 | 4353. | 2841. | 2094. |
| 40 | 4221. | 2758. | 1914. |
| 41 | 4081. | 2671. | 1725. |
| 42 | 3946. | 2580. | 1542. |
| 43 | 3826. | 2485. | 1378. |
| 44 | 3718. | 2387. | 1231. |
| 45 | 3621. | 2286. | 1101. |
| 46 | 3535. | 2182. | 984.  |
| 47 | 3458. | 2075. | 879.  |
| 48 | 3389. | 1965. | 791.  |
| 49 | 3326. | 1852. | 741.  |
| 50 | 3266. | 1736. | 693.  |
| 51 | 3211. | 1617. | 649.  |
| 52 | 3159. | 1504. | 607.  |
| 53 | 3110. | 1387. | 568.  |
| 54 | 3065. | 1267. | 532.  |
| 55 | 3022. | 1144. | 498.  |
| 56 | 2983. | 1018. | 466.  |
| 57 | 2945. | 890.  | 436.  |
| 58 | 2910. | 760.  | 408.  |
| 59 | 2878. | 628.  | 382.  |
| 60 | 2847. | 495.  | 357.  |
| 61 | 2818. | 360.  | 335.  |
| 62 | 2792. | 224.  | 313.  |
| 63 | 2766. | 90.   | 293.  |
| 64 | 2743. | 0.    | 274.  |
| 65 | 2721. | 0.    | 257.  |
| 66 | 2700. | 0.    | 240.  |
| 67 | 2681. | 0.    | 225.  |
| 68 | 2663. | 0.    | 210.  |
| 69 | 2646. | 0.    | 197.  |
| 70 | 2630. | 0.    | 184.  |
| 71 | 2616. | 0.    | 172.  |
| 72 | 2602. | 0.    | 161.  |
| 73 | 2589. | 0.    | 151.  |
| 74 | 2577. | 0.    | 141.  |
| 75 | 2565. | 0.    | 132.  |
| 76 | 2555. | 0.    | 124.  |
| 77 | 2545. | 0.    | 116.  |
| 78 | 2536. | 0.    | 108.  |
| 79 | 2527. | 0.    | 101.  |
| 80 | 2519. | 0.    | 95.   |
| 81 | 2511. | 0.    | 89.   |
| 82 | 2504. | 0.    | 81.   |
| 83 | 2497. | 0.    | 78.   |
| 84 | 2491. | 0.    | 73.   |
| 85 | 2485. | 0.    | 68.   |



PIRELLA GÖTTSCHE LOWE

|     |       |    |     |
|-----|-------|----|-----|
| 86  | 2480. | 0. | 64. |
| 87  | 2475. | 0. | 60. |
| 88  | 2470. | 0. | 56. |
| 89  | 2465. | 0. | 52. |
| 90  | 2461. | 0. | 48. |
| 91  | 2457. | 0. | 46. |
| 92  | 2453. | 0. | 43. |
| 93  | 2450. | 0. | 40. |
| 94  | 2447. | 0. | 37. |
| 95  | 2444. | 0. | 35. |
| 96  | 2441. | 0. | 33. |
| 97  | 2438. | 0. | 30. |
| 98  | 2436. | 0. | 28. |
| 99  | 2433. | 0. | 27. |
| 100 | 2431. | 0. | 25. |
| 101 | 2429. | 0. | 23. |
| 102 | 2427. | 0. | 22. |
| 103 | 2426. | 0. | 20. |
| 104 | 2424. | 0. | 19. |
| 105 | 2422. | 0. | 16. |
| 106 | 2421. | 0. | 17. |
| 107 | 2419. | 0. | 15. |
| 108 | 2418. | 0. | 14. |
| 109 | 2417. | 0. | 14. |
| 110 | 2416. | 0. | 13. |
| 111 | 2415. | 0. | 12. |
| 112 | 2414. | 0. | 11. |
| 113 | 2413. | 0. | 10. |
| 114 | 2412. | 0. | 10. |
| 115 | 2411. | 0. | 9.  |
| 116 | 2411. | 0. | 6.  |
| 117 | 2410. | 0. | 6.  |
| 118 | 2409. | 0. | 7.  |
| 119 | 2409. | 0. | 7.  |
| 120 | 2408. | 0. | 6.  |
| 121 | 2407. | 0. | 6.  |
| 122 | 2407. | 0. | 5.  |
| 123 | 2406. | 0. | 5.  |
| 124 | 2406. | 0. | 5.  |
| 125 | 2406. | 0. | 4.  |
| 126 | 2405. | 0. | 4.  |
| 127 | 2405. | 0. | 4.  |
| 128 | 2404. | 0. | 3.  |
| 129 | 2404. | 0. | 3.  |
| 130 | 2404. | 0. | 3.  |
| 131 | 2404. | 0. | 2.  |
| 132 | 2403. | 0. | 3.  |
| 133 | 2403. | 0. | 2.  |
| 134 | 2403. | 0. | 2.  |
| 135 | 2403. | 0. | 2.  |
| 136 | 2402. | 0. | 2.  |
| 137 | 2402. | 0. | 2.  |
| 138 | 2402. | 0. | 1.  |
| 139 | 2402. | 0. | 1.  |
| 140 | 2402. | 0. | 1.  |
| 141 | 2402. | 0. | 1.  |
| 142 | 2401. | 0. | 1.  |
| 143 | 2401. | 0. | 1.  |
| 144 | 2401. | 0. | 1.  |
| 145 | 2401. | 0. | 1.  |
| 146 | 2401. | 0. | 1.  |

1900-1901 (1900-1901) ...

|        | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|--------|--------|---------|---------|--------------|
| 197    | 2401.  | 0.      | 0.      | 1.           |
| 198    | 2401.  | 0.      | 0.      | 1.           |
| 199    | 2401.  | 0.      | 0.      | 0.           |
| 200    | 2401.  | 0.      | 0.      | 0.           |
| SUM    |        |         |         | 128245.      |
| PEAK   | 4952.  | 3867.   | 1753.   | 128245.      |
| CFS    | 2.22   | 6.95    | 9.43    | 9.60         |
| INCHES | 2456.  | 7674.   | 10440.  | 10604.       |
| AC-FT  |        |         |         |              |

TEOT

1900 SANTI NAVARO DI RIVET CUI CHIARA 86274

111

RUNOFF SUMMARY: AVERAGE FLOW

| HYDROGRAPH AT<br>ROUTED TO | PEAK  | 6-HOUR | 24-HOUR | 72-HOUR | AREA  |
|----------------------------|-------|--------|---------|---------|-------|
| 1                          | 6413. | 5945.  | 4492.   | 1701.   | 20.70 |
| 1                          | 5041. | 4952.  | 3067.   | 1753.   | 20.70 |



1001 SOUTH MAIN ST., DENVER, COLORADO 80224



APPENDIX E

INFORMATION AS CONTAINED IN THE  
NATIONAL INVENTORY OF DAMS



# INVENTORY OF DAMS IN THE UNITED STATES

|                 |       |        |       |                 |                    |                  |                  |                             |
|-----------------|-------|--------|-------|-----------------|--------------------|------------------|------------------|-----------------------------|
| IDENTITY NUMBER | STATE | COUNTY | DIST. | CONTRACT NUMBER | NAME               | LATITUDE (NORTH) | LONGITUDE (WEST) | REPORT DATE (DAY / MO / YR) |
| 285             | NH    | 013    | 01    |                 | NORTHWOOD LAKE DAM | 4313.2           | 7117.5           | 15OCT78                     |

|                      |  |          |                      |                       |                        |            |
|----------------------|--|----------|----------------------|-----------------------|------------------------|------------|
| POPULAR NAME         | NAME OF IMPROVEMENT                      |          |                      |                       |                        |            |
|                      | NORTHWOOD LAKE                           |          |                      |                       |                        |            |
| RIVER OR STREAM      | NEAREST DOWNSTREAM CITY - TOWN - VILLAGE |          |                      |                       |                        |            |
| LITTLE SUNCOOK RIVER | EPSON                                    |          |                      |                       |                        |            |
| TYPE OF DAM          | YEAR COMPLETED                           | PURPOSES | STRAIN HEIGHT (FEET) | HYDRAULIC HEAD (FEET) | ADJACENT AREAS (ACRES) | POPULATION |
| CTPG                 | 1926                                     | RC       | 13                   | 13                    | 3000                   | 200        |

|      |     |     |   |     |     |     |   |     |      |
|------|-----|-----|---|-----|-----|-----|---|-----|------|
| DIST | OWN | FED | R | PRV | PFD | SCS | A | VER | DATE |
|      |     |     |   |     |     |     |   |     |      |

|         |          |                        |                       |                     |                        |                  |
|---------|----------|------------------------|-----------------------|---------------------|------------------------|------------------|
| D/S HAS | SPILLWAY | MAXIMUM DISCHARGE (CF) | VOLUME OF DAM (CU YD) | POWER CAPACITY (KW) | REVALUED PROPOSED (KW) | NAVIGATION LOCKS |
| 1       | 165 C    | 109                    | 350                   |                     |                        |                  |

|                 |                |                 |
|-----------------|----------------|-----------------|
| OWNER           | ENGINEERING BY | CONSTRUCTION BY |
| WM WATER RES BD |                |                 |

|        |              |           |             |
|--------|--------------|-----------|-------------|
| DESIGN | CONSTRUCTION | OPERATION | MAINTENANCE |
| NONE   | NONE         | NONE      | NONE        |

|                       |                                 |                          |
|-----------------------|---------------------------------|--------------------------|
| INSPECTION BY         | INSPECTION DATE (DAY / MO / YR) | AUTHORITY FOR INSPECTION |
| HARRIS-ECI ASSOCIATES | 05 JUN 78                       | PL 92-367                |

|         |
|---------|
| REMARKS |
|         |

LMED  
— 8